

RCAR Bumper Test

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1.0 INTRODUCTION

This document describes the RCAR bumper test procedure that assesses bumper performance.

The RCAR Bumper Test encourages vehicle manufacturers to produce effective bumper systems that feature tall energy absorbing beams and crash boxes, that are fitted at common heights and can effectively protect the vehicle in low speed crashes.

In the opinion of RCAR, good vehicle bumper beams should:

- be fitted to both the front and rear of vehicles
- be replaceable without cutting / welding
- incorporate a beam height exceeding 100 mm
- be positioned to fully engage with the front and rear bumper barriers
- be torsion-resistant to carry eccentric loads without twisting
- absorb energy and restrict damage to the bumper system only
- be attached to the body via energy absorbing structures that are inexpensive to repair or replace
- be stable during impacts to prevent underride and override.
- prevent damage to structural, welded or bonded and other expensive parts
- extend laterally to protect the corners of the vehicle.



Fig. 1: Bumper barrier

2.0 SCOPE

Improving passenger car damageability and repairability has been an important RCAR topic since the Council was established in 1972. In order to prevent unnecessary damage to the structure of passenger cars in low speed crashes, a 15 km/h and 40 % overlap was implemented in the 1980s and revised again in 2006 (Changed from 0° to 10° impact angle and the rear impact moving barrier from 1000 to 1400kg) now referred to as the “**RCAR Structural Test**”

Car manufacturers design their vehicles to perform well in this RCAR structural test but some have fitted vehicles with countermeasures that do not exhibit good crash behaviour in real world accidents. In some cases manufacturers have eliminated the bumper beam and replaced them with localized countermeasures to manage the test, such as crush cans. Such sub-optimised designs are in most cases not robust and often lead to expensive damage in car-to-car accidents.

Insurance claim data indicates that rear bumpers are often underridden by a striking vehicle due to bumper system instability or vertical dive of vehicles during braking. In these cases it is desirable to have bumper systems that have sufficient vertical overlap to maintain engagement. To this end bumpers should ideally be mounted at slightly different heights front and rear but be of sufficient height to maintain engagement over a wide range of circumstances. However, insurance data also show that rear bumpers are overridden when struck by high ride-height vehicles (SUVs, pickup trucks). Vehicle damageability would be improved in both these situations with taller front and rear bumper beams.

An international RCAR working group has investigated a new test procedure to assess how well a vehicle’s bumper system protects the vehicle from damage in low-speed impacts. The new test closely replicates the damage patterns observed in real-world low-speed crashes and addresses three components of bumper performance:

1. Geometry – vehicle bumpers need to be positioned at common heights from the ground to properly engage each other in crashes
2. Stability – vehicle bumpers need to be tall and wide enough to remain engaged with the bumpers of other vehicles despite vehicle motion due to loading, braking, etc.
3. Energy-absorption – vehicle bumpers should absorb low-speed crash energy without damage to other parts of the vehicle.

The new bumper test incorporates a rigid bumper-shaped barrier fitted with an energy-absorbing material and cover. The barrier, shown in figure 1, is 100 mm tall and is mounted to an immovable surface and impacted by test vehicles. The limited height of the barrier encourages uniform vehicle bumper heights from the ground. The deformable energy-absorbing element encourages designs that remain stable when impacting deformable material, like another vehicle’s bumper system. It also features a solid rear “backstop” that can replicate real world damage severities where underride occurs. Lastly, it encourages designs that absorb crash energy while limiting intrusion into the vehicle.

3.0 DEFINITIONS

Bumper Barrier:

The rigid steel contoured barrier described in Appendix 1, section 2.0 and 4.0.

Bumper Backstop:

The rigid steel contoured plate on top of the barrier described in Appendix 1, section 2.2.

Energy Absorber:

The energy absorbing element attached to the face of the bumper barrier described in Appendix 1, section 3.0 and 4.0.

Energy Absorber Cover:

The cover to the energy absorbing element listed above is intended to form an even contact surface. This can be an integral part of the EA element or a separate part.

Bumper Barrier Assembly:

The bumper barrier with the backstop attached to the top and the energy absorbing element attached to the face.

Barrier Ground Clearance:

The distance from the track surface to the lower surface of the bumper barrier.

Bumper Cover:

The plastic cosmetic fascia that covers the vehicle bumper beam.

Bumper Beam:

Structural cross member under the bumper fascia protecting the front or rear of the vehicle.

(Note: The beam does not include foam, cover support or pedestrian protection devices, see 5.5).

Bumper Beam Height:

Maximum vertical distance measured between the highest and lowest points on the bumper beam profile.

Qualifying Bumper Beam Height:

Aggregate vertical distance, determined by the measuring procedure described in section 5.2 to 5.6.

Relevant Bumper Engagement:

Vertical overlap of the bumper barrier and the vehicle's qualifying bumper beam height (section 5.7).

Geometric Penalty:

An adjustment to the bumper rating due to insufficient relevant engagement.

Vehicle Nominal Ride Height:

The nominal ground clearance between the highest point of the outer wheel arch vertically above the wheel center and ground as defined by the manufacturer in the model specifications (or other body reference points designated by the manufacturer).

Vehicle Reference Height:

Ground clearance of the wheel arches (or reference points) of the individual test vehicle under static test conditions.

4.0 VEHICLE SET-UP CONDITION

The vehicle to be tested should be at the vehicle manufacturers nominal kerb weight plus fuel plus the additional test devices as stated.

The vehicle should be at the nominal ride height (± 10 mm) as specified by the vehicle manufacturer.

If appropriate the test house may decide to test vehicles in the “as delivered” condition.

Tyre pressure: as specified by vehicle manufacturer under single occupant loading and low speed conditions

Load: 75 kg \pm 5 kg test dummy or equivalent on the driver’s seat, secured with the standard 3-point seat belt.
Fuel tank filled to min. 90% capacity with fuel or substitute to appropriate mass, or weight equivalent near the tank position also permissible.

Additional weight of necessary test equipment may be added without removing vehicle parts for compensation.
The equipment shall be placed in a low position (e.g. on the floor) to reduce its influence on the vertical vehicle dynamics (i.e. pitch)

Measurements: Actual vehicle's mass in test configuration
Vehicle reference height at test condition
Bumper geometry as specified in no. 5.2 – 5.7

5.0 GEOMETRIC ASSESSMENT

5.1 Basic requirements

Some vehicles with a bumper system optimised to the test procedure may not over- or underide in the dynamic bumper test but they may not perform well under real world conditions.

Bumper beams that have insufficient vertical height will be presumed to fail the test. These include:

- a) bumper systems that do not feature bumper beams as defined above
- b) small bumper beams with insufficient vertical height
- c) bumper beams that do not engage (overlap) the bumper barrier sufficiently.

RCAR has developed a measuring procedure to assess case b) and c) above. Based on this procedure bumper beams are likely to be insufficient, if the

Relevant bumper engagement is $< 75 \text{ mm}$ (see figure 5 in section 5.7).

Some vehicles may fail to reach this engagement due to their design, but are equipped with tall bumper beams which may perform well in real accidents.

Therefore vehicles with **qualifying bumper beam heights** (see fig. 2 in section 5.2) **of 100 mm or more** shall be subject to the dynamic test, if the relevant bumper engagement is less than 75 mm when a reasonable test result can be anticipated.

The vehicles bumper system must sufficiently engage with the bumper barrier to be deemed acceptable. Bumper beams that do not target the bumper barrier and use the backstop for energy management instead, will be regarded as unacceptable.

Vehicles with less measured qualifying bumper beam height and relevant engagement do not warrant testing and the test organisation may decide to apply a penalty.

Test houses may decide to test vehicles with the insufficient engagement and beam height e.g. in order to demonstrate poor behaviour.

5.2 Measuring procedure

After removing all detachable components (e.g. energy absorbing materials) the bumper beam height shall be measured from a vertical plane contacting the beam **10 mm** into the profile to get the qualifying bumper beam height. The procedure is shown in fig. 2.

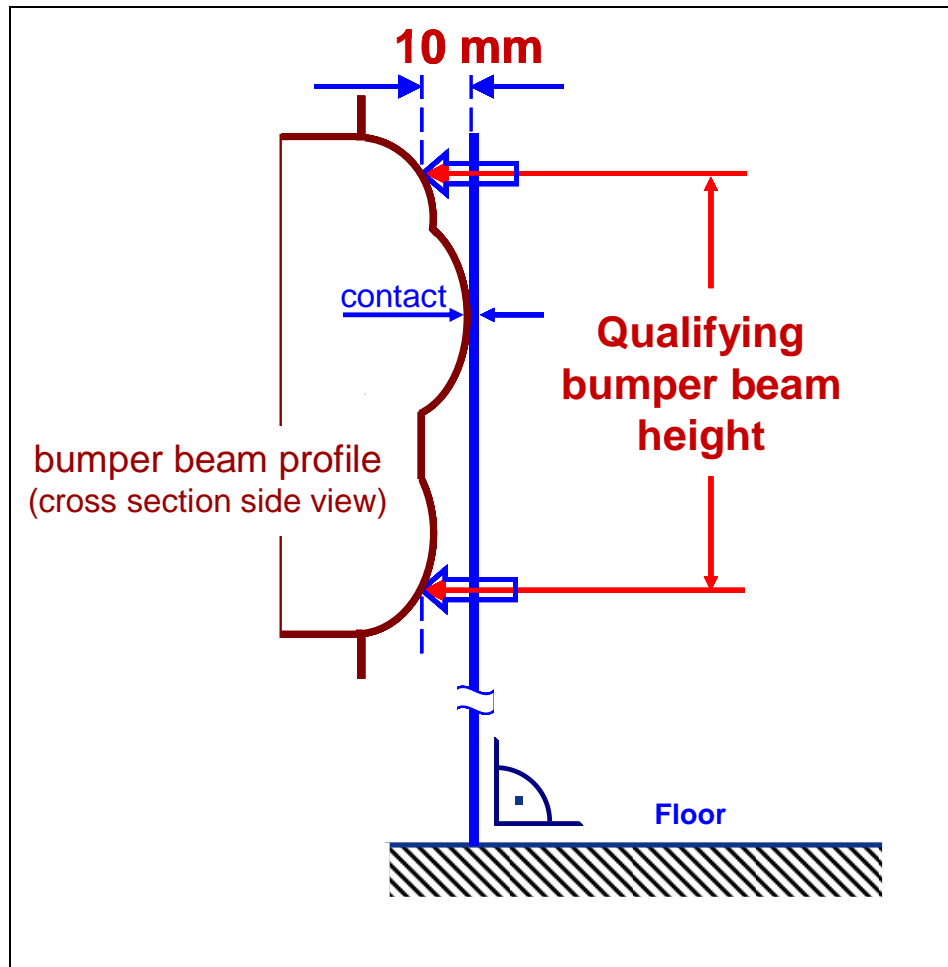


Fig. 2: Measuring the qualifying bumper beam height

5.3 Measuring position

The beam is measured on three positions as indicated in fig. 3

- in the centre of the vehicle (C)
- in front of the centre of the side rails (crash boxes) right (R) and left (L) (both, because they may be different)
- all three values are measured within a band width of ± 50 mm.

The minimum within each band is taken.

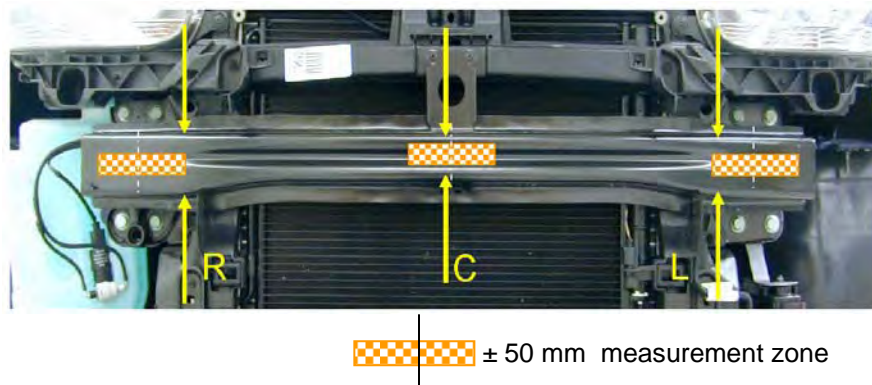


Fig. 3: Bumper beam measuring positions

5.4 Mean value

The values "R" and "L" are weighted 25%, the value "C" is weighted 50%.

Example: $R=90$, $L=90$, $C=60$

→ Qualifying bumper beam height = $(90+90)*0,25 + 60*0,5 = 75$ mm.

5.5 Pedestrian protection

If non detachable components for pedestrian protection are integral with the bumper beam, only the bumper beam should be measured.

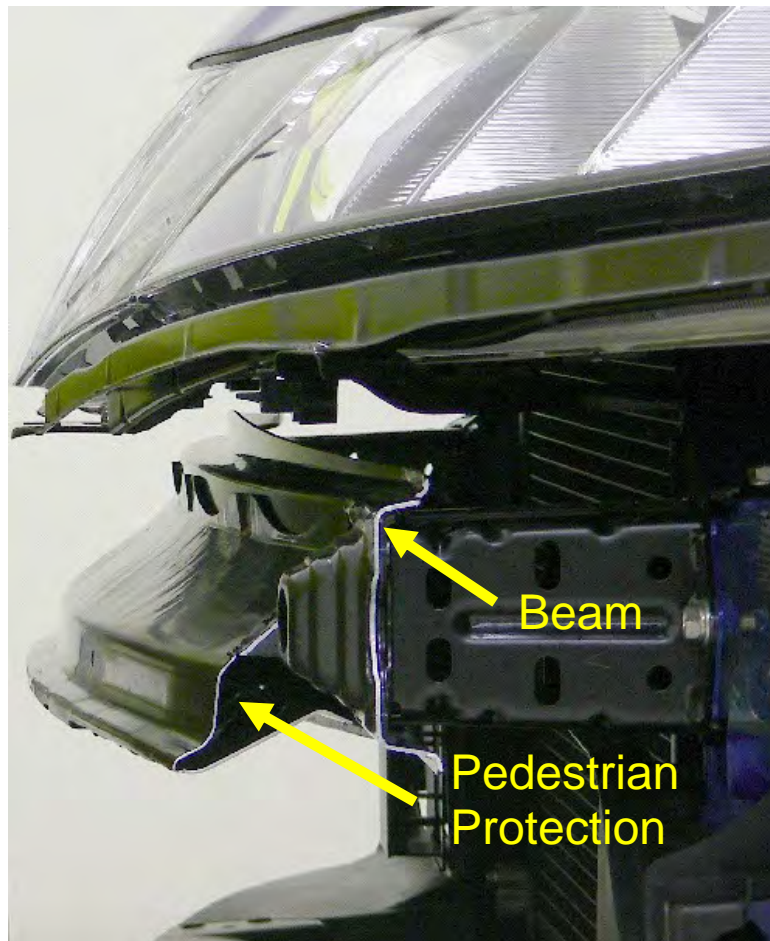


Fig. 4: Bumper beam with pedestrian protection elements

5.6 Flanges

Elements of the bumper beam that are not of sufficient strength on the outer edges such as flanges will be disregarded. Instead, the structure behind (within the 10 mm range, as in no. 5.2) is measured.

A flange thickness of 5 mm or more may be regarded as “structural”, as well as a flange, or the part of it, which is not higher than the flange material thickness.

Special materials (e.g. high strength steel) and/or shapes (e.g. corrugated) and/or supports may be used in the measurement as well, if appropriate.

5.7 Relevant bumper engagement

Before measuring the relevant engagement, the vehicle reference height must be verified. The relevant engagement results from the qualifying beam height and its ground clearance relative to the bumper barrier ground clearance for the intended test, fig. 5.

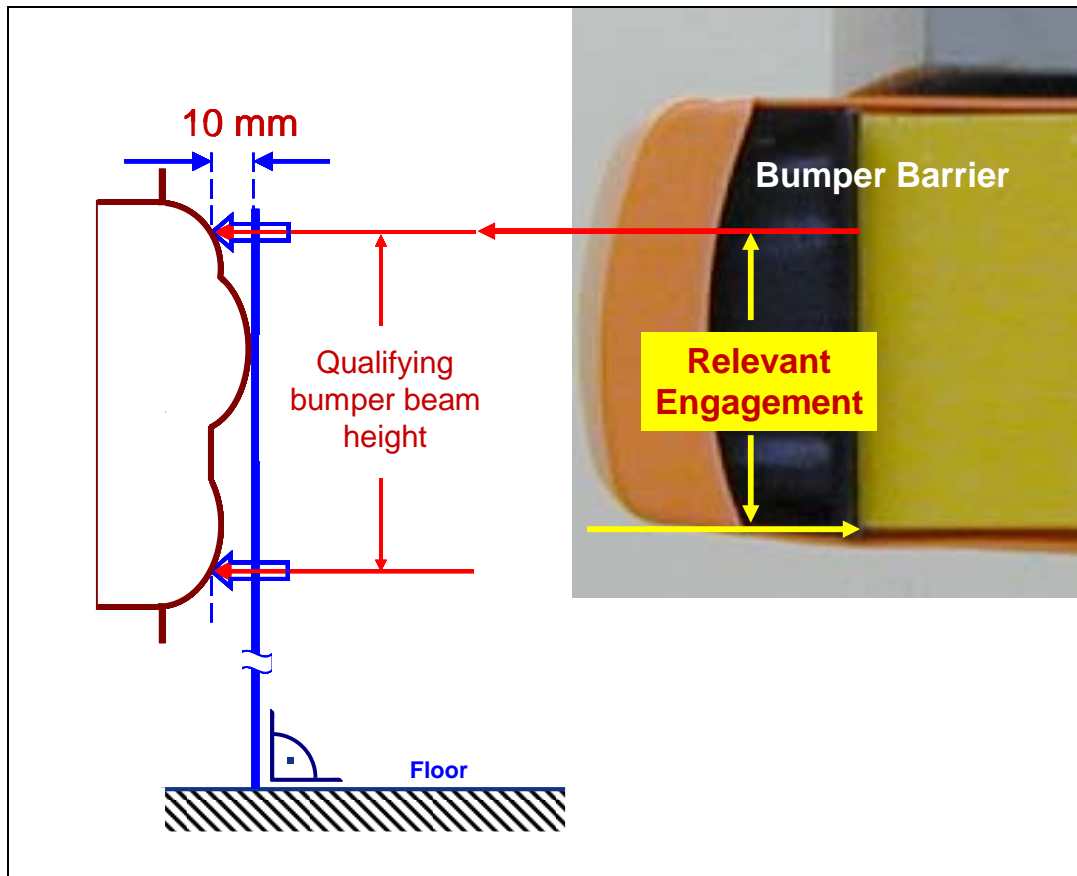


Fig. 5: Relevant bumper engagement

6.0 DYNAMIC TEST

Insurance claims data indicate that rear bumpers are often overridden by the striking vehicle when vehicles of similar type collide due to the influence of dynamic vertical dive of vehicles during braking. Due to this the front and rear bumper tests are undertaken at differing heights.

Insurance data also show that rear bumpers are overridden when struck by high ride-height vehicles (SUVs, pickup trucks). In markets where such vehicles are common the rear test may be conducted at the higher mounting position to prevent override.

6.1 Barrier position

The barrier ground clearance shall be

- **455 mm for frontal impact (± 3 mm)**
- **405 mm or 455 mm (± 3 mm) for rear impacts** (depending on local market)

6.2 Vehicle set-up

In addition to the static set-up as specified in section 4, the following requirements and recommendations apply for the dynamic test:

Condition: Air conditioning system drained and pressure checked, if necessary.
 Live electrical system with ignition at position 2.
 Safety equipment (belt pretensioner, airbags) live.
 Brakes released and gear lever in neutral position *)

Measurements: Axle alignment and body gaps checked before and after the impact
 Vehicle reference height at t_0
 Impact speed
 Recommended: Body measurement
 Recommended: Vehicle acceleration
 on left and right B pillar base and/or centre.

**) Not required if the car is not running on own wheels*

6.3 Vehicle movement

Moving barriers show considerable vertical dynamic movement during a crash due to inertial properties, suspension, tyres, etc. This movement would degrade the test reproducibility and repeatability unacceptably. Therefore both the front and rear bumper barrier tests shall be conducted with a moving car striking the fixed bumper barrier. Test house shall ensure drive systems or vehicle speed controls do not influence the test condition. At the moment of impact the vehicle shall be free of relevant exterior or propelling forces (to stabilize the approach some drag may be allowed, e.g. using hand brake).

6.4 Vehicle Position

At the impact the centreline of the car shall be aligned with the centre of the bumper barrier. With regard to variations between guidance systems a maximum lateral deviation of up to ± 50 mm is permissible.

When the car dynamically approaches the impact point, the vehicle reference height at crash condition should be as close as possible to the height measured under static conditions before the crash (a deviation of not more than ± 10 mm is desirable). If a larger deviation occurs, the test house shall evaluate its influence on the test behaviour and its possible relevance for the test result.

Appropriate measurement equipment shall be used to verify the vertical vehicle alignment. The vehicle reference height at t_0 shall be documented.

6.5 Impact Velocity

The impact velocity shall be $10.0 \text{ km/h} \pm 0.5 \text{ km/h}$

7.0 IMPLEMENTATION

Whilst this RCAR Bumper Test should encourage vehicle manufacturers to produce effective bumper systems, RCAR members (or the associated test organisations) are free to adopt the bumper test in their country. They may decide to use the results from the test in differing ways for rating or consumer information purposes to suit local market conditions.
