Side Impact Crashworthiness Evaluation
Deformable Barrier 2.0 Dynamic Test Protocol

Version I

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CONTENTS

SCOPE

This protocol describes the procedures for testing version 2.0 of the IIHS deformable barrier in a dynamic configuration. In this configuration, the crash cart fitted with the deformable barrier strikes a stationary fixture mounted to a wall.

Supporting documents for the Insurance Institute for Highway Safety (IIHS) side impact crash test program are available from the *Test protocols and technical information* section of the IIHS website.

PURPOSE

The design and performance criteria described in this specification are intended to supplement the static moving deformable barrier specification to

- provide a measurement tool with sufficient precision to ensure repetitive and correlative results under similar loading conditions and
- reflect adequately the protective performance of a motor vehicle or item of motor vehicle equipment with respect to human occupants.

DYNAMIC TEST PROTOCOL

Impact configuration

The dynamic barrier test consists of a rigid T-shaped fixture that is mounted to a wall with a load cell array and impacted by a crash cart fitted with a deformable element on its striking face.

The 1,900-kg moving deformable barrier (MDB) has an impact velocity of 30 km/h $\pm$ 1 km/h and strikes the rigid wall-mounted T-shaped fixture at a 90-degree angle.

The fixture should be aligned with the MDB such that there is a 75-mm $\pm$ 15-mm vertical overlap between the bottom of the bumper section and the top of lower T-impactor bar, as shown in Figure 1A. The lateral centerline of the barrier should be aligned $\pm$ 15 mm with the centerline of the T-shaped impactor, as shown in Figure 1B.

Test alignment is verified using video analysis. Stickers or other consumable targets that have been placed on the T-shaped impactor and honeycomb barrier (choice of location and type of target at the discretion of each test lab) are confirmed to be within the range using video footage.

Figure 1A. Vertical barrier alignment

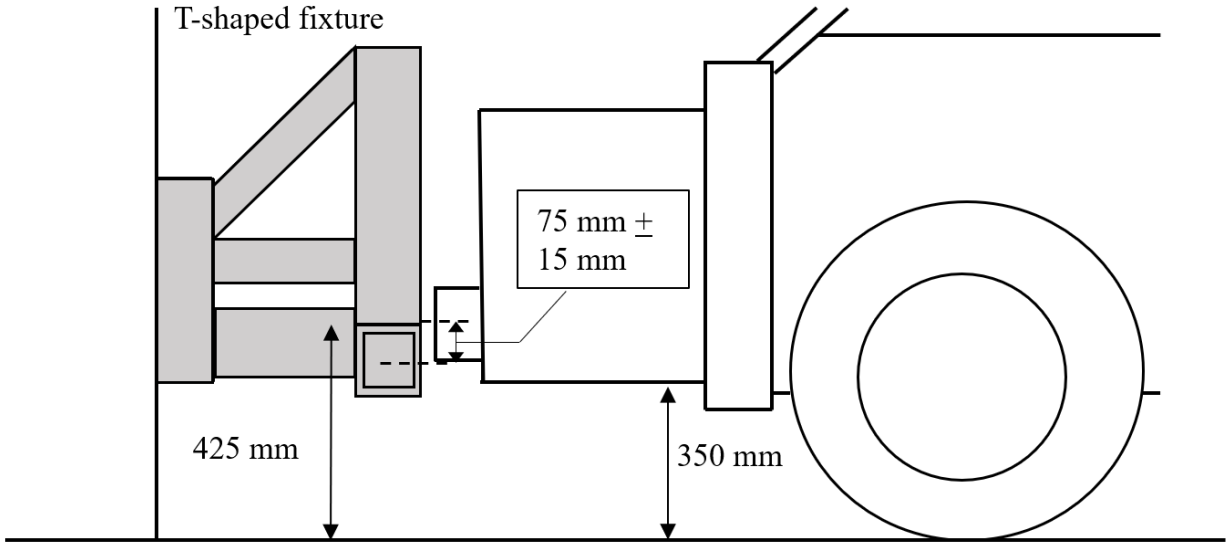
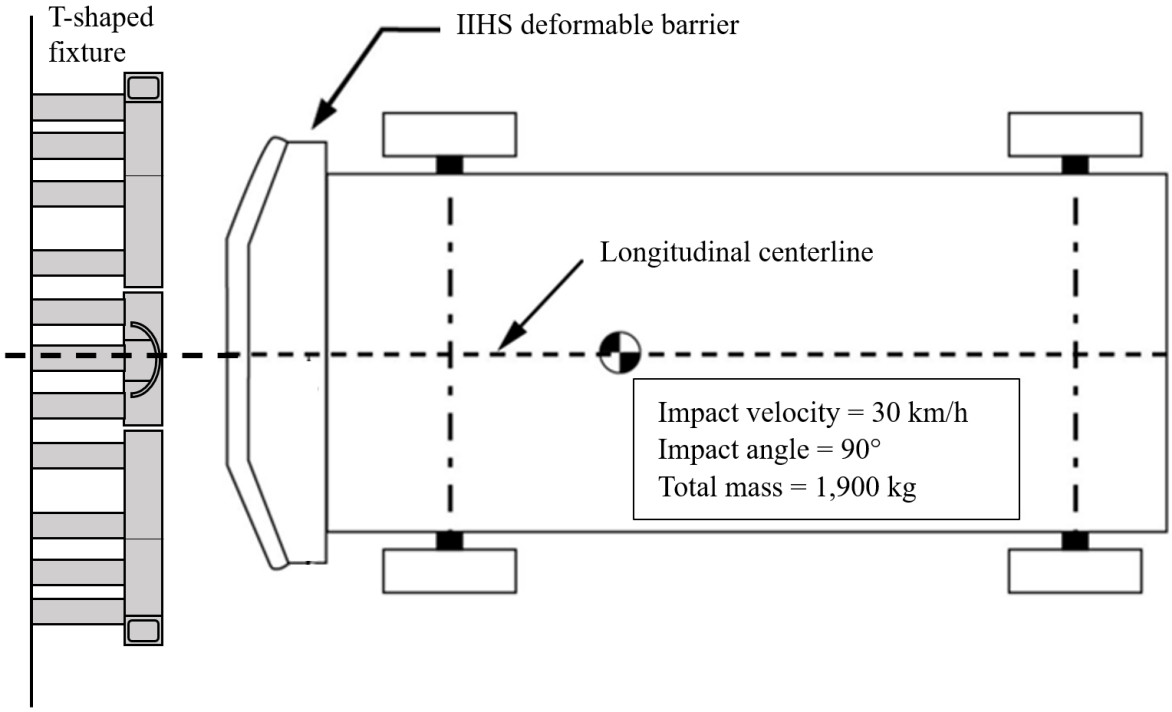


Figure 1B. Lateral barrier alignment

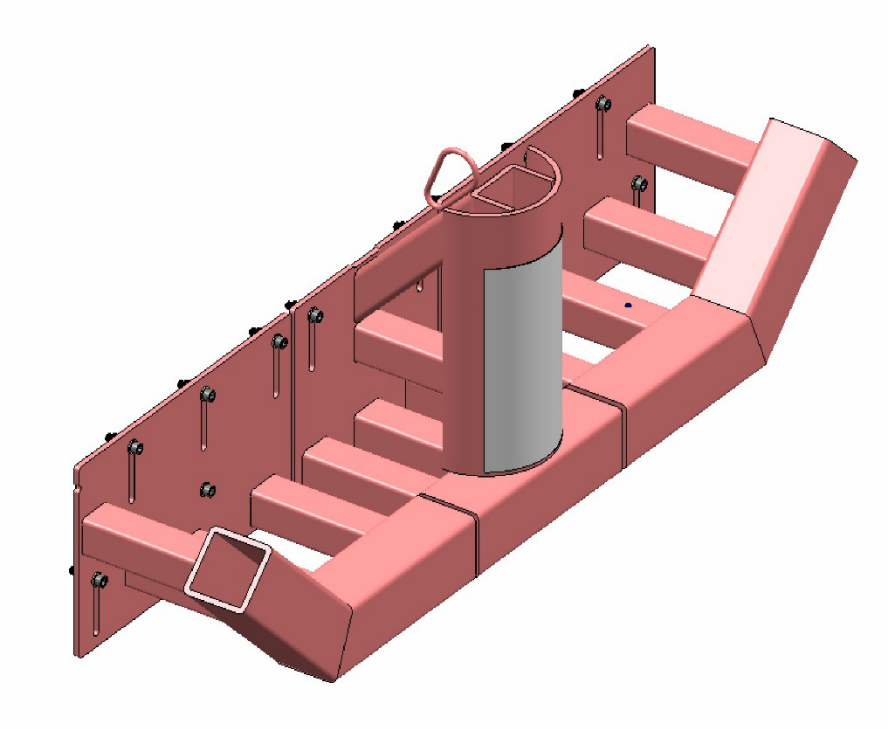


T-shaped fixture

The T-shaped fixture consists of three rigid segments and a Teflon sheet attached to the front face of the center vertical section, as shown in Figure 2.

Behind the rigid fixture is an array of load cells. The T-shaped impactor design is documented in the S*ide Impact Crashworthiness Evaluation 2.0: Dynamic Barrier Fixture Drawing Package, Version* I (IIHS, 2023), which contains detailed drawings of the fixture for fabrication.

Figure 2. T-shaped fixture



Moving deformable barrier

The MDB consists of an IIHS deformable aluminum barrier (2.0) and the cart to which it is attached as defined in the *Side Impact Crashworthiness Evaluation 2.0: Crash Test Protocol, Version II* (IIHS, 2022). The MDB test weight is 1,900 ± 5 kg with the deformable element and test instrumentation.

The IIHS deformable barrier design and performance criteria are documented in the *Side Impact Crashworthiness Evaluation: Deformable Barrier 2.0 Specification, Version II* (IIHS, 2022); detailed drawings are also included.

Photography

Still photography

The precrash and postcrash conditions of each test barrier are photographed. Details of the required photos are shown in Table 1.

Table 1. Still photography documentation, both precrash and postcrash

Location	Wide	Tight
Overhead	X	X
Right side	X	X
Right side oblique	X	X
Left side	X	X
Left side oblique	X	X
Underbody	X	X

High-speed motion picture photography

Motion picture photography is made of the test with high-speed digital imagers. All high-speed imagers record at 1,000 frames per second. The locations of the offboard cameras are listed in Table 2.

Table 2. High-speed video documentation

Location	Wide	Tight
Overhead	X	X
Left side	X	X
Right side	X	X
Underbody	Optional	Optional

INSTRUMENTATION AND DATA PROCESSING

Load cell wall

A variety of configurations can be used to obtain the required force data. The T-shaped impactor can be attached directly to a load cell wall, or individual load cells can be attached to the back of the baseplate between the fixture and a rigid wall. Ideally, the T-shape impactor should be mounted so that load cells do not span multiple segments of the fixture (left, center, right) but if wall dimensions do not allow for this, any load cell spanning multiple segments will not be considered for analysis.

After the data have been downloaded from the data acquisition systems, any initial offset from zero is removed from each channel by computing the mean value for 100 data points preceding the crash event (from 50 to 40 ms before impact) for each channel and subtracting each mean from the respective data channel.

The data are presented filtered according to the channel frequency class (CFC) 60 as defined in the Society of Automotive Engineers (SAE) standard *Surface Vehicle Recommended Practice J211/1* (2014). All filtering and subsequent calculations are executed using data analysis software.

All measurements are recorded at a sample rate of 10 kHz. Signals in all channels convert simultaneously, so the time reference for different channels is not skewed.

The load cells in each segment (left, center, right) are added, resulting in left total, right total, and center total force curves. Any load cells overlapping more than one segment of the fixture should be excluded from this calculation.

MDB acceleration

An accelerometer placed at the MBD lateral centerline close to the center of gravity is used to measure X-axis accelerations. A redundant set of accelerometers may also be installed.

Time zero

Time zero is defined by a tape switch located on any structural part of the T-shaped fixture that will make first contact with the honeycomb barrier face.

All data are digitally filtered using the frequency response classes recommended in *SAE Surface Vehicle Recommended Practice J211/1* (2014). The longitudinal accelerometer is to be double integrated for the cart stroke calculation.

Force-displacement curves

The calculated summed load for each segment is plotted vs. the cart stroke and evaluated against the corridors specified in the ratings guideline.

DYNAMIC TEST CORRIDORS

Performance corridors are applied to the force-displacement curves for the center, left, and right sections. The corridor for the center is separate from the corridor for the left and right sections. These values are shown in Tables 4 and 5.

To pass the corridor, the force-displacement curve must remain within the corridor range for the entire length of the range.

Table 4. Center corridors

	Range 1		**Range 2**		**Range 3**		**Range 4**	
Lower	X (mm)	Y (kN)	X (mm)	Y (kN)	X (mm)	Y (kN)	X (mm)	Y (kN)
Start	20	16	110	34	160	65	210	72
End	80	34	140	56	190	65	275	86
Upper								
Start	20	38	110	56	160	86	210	97
End	80	56	140	80	190	86	275	111

Table 5. Left and right corridors

	Range 1		**Range 2**		**Range 3**	
Lower	X (mm)	Y (kN)	X (mm)	Y (kN)	X (mm)	Y (kN)
Start	20	6	100	20	150	69
End	70	14	130	55	270	123
Upper						
Start	20	30	85	48	150	117
End	70	38	120	89	260	167

TEST DOCUMENTATION

Standard certification sheet

Each barrier must have (included in its shipping container or in electronic format) a certification package that provides information demonstrating passing performance in this dynamic test condition. This package must include graphs of the left, right, and center force-displacement curves plotted with the respective corridors.

Frequency

A single test result demonstrating passing performance is valid for every 200 barriers produced or every 24 months, whichever comes first.

Auditing

IIHS reserves the right to ask for a detailed report showing passing performance for any barriers purchased by IIHS or used in IIHS verification testing. In addition to the standard certification sheet, this detailed report includes photography, video, and data produced in accordance with this test protocol.

REFERENCES

Insurance Institute for Highway Safety. (2022). *Side impact crashworthiness evaluation: Deformable barrier 2.0 specification, Version II*.

Insurance Institute for Highway Safety. (2022). *Side impact crashworthiness evaluation 2.0: Crash test protocol, Version II*.

Insurance Institute for Highway Safety. (2023). *Side impact crashworthiness evaluation 2.0: Dynamic barrier fixture drawing package, Version I.*

Society of Automotive Engineers. (2014). Surface vehicle recommended practice J211/1; Instrumentation for impact test, Part 1: Electronic instrumentation.