

Wheel Radial Impact Test Procedure for Passenger Cars

RATIONALE

A laboratory test is provided to simulate the impact imparted to a tire and wheel assembly from a pothole and or above the road surface road hazard.

1. SCOPE

This SAE Recommended Practice defines the test stand and procedure for evaluating radial impacts of all wheels intended for passenger cars and light trucks. A minimum performance requirement is intentionally not provided. The intent is to establish a uniform method and test stand for imparting damage and evaluating radial impacts. A minimum performance requirement will be a proposed change when users determine what is of most value.

1.1 Background

Thousands of wheels were inspected from warranty returns in the United States. Roughly 90% of the damage to the wheel was located on the inboard flange only. Additionally, the magnitude of the damage to the inboard flange typically exceeded that of the outboard flange. This test strikes the inner half of the wheel only, replicating damage found in wheels inspected from service.

The test stand is similar to that described in AK-LH 08, a European wheel specification. This test stand uses less mass and more drop height to replicate the impact phenomena seen in service. The mass of the striker is the least practical allowing the drop height to be increased providing velocities that strike more like that found in service. Optionally, load cells are added to allow dynamic force measurement. The lower mass of the striker makes it easier to catch after the first impact and before a subsequential strike.

The energy of impact is controlled through varying the drop height from 0.4 to 1.4 m. The repeatability is improved by the large difference of drop height. When the wheel is sequentially impacted from progressively higher drop heights, a curve of the permanent deformations relative to drop heights is available. This curve can project two regimes of deformations. The first regime is when air remains between the pinched tire sidewall and wheel flange. The second regime is when there is no air between the pinched tire sidewall and wheel flange which will be termed strike-through. The second regime is far more damaging to the wheel, so the point of strike-through can be of importance to the vehicle and wheel manufacturer.

The drop height is capped at 1.4 m so the test stand can fit in a building with 7 m ceilings. One can add 25 kg to have the same energy as dropping from 1.6 m and add 50 kg to have the same energy as dropping from 1.8 m, etc.

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Documents

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J175	Wheels - Lateral Impact Test Procedure - Road Vehicles
SAE J328	Wheels - Passenger Car and Light Truck Performance Requirements and Test Procedures
SAE J393	Nomenclature - Wheels, Hubs, and Rims for Commercial Vehicles
SAE J1981	Road Hazard Impact Test for Wheel and Tire Assemblies (Passenger Car, Light Truck, and Multipurpose Vehicles)
SAE J1982	Nomenclature - Wheels for Passenger Cars, Light Trucks, and Multipurpose Vehicles
SAE J2530	Aftermarket Wheels - Passenger Car and Light Truck - Performance Requirements and Test Procedures
SAE J3204	Aftermarket Composite Wheels Made of Matrix Material and Fiber Reinforcement Intended for Normal Highway Use - Test Procedures and Performance Requirements

2.1.2 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 3911	Wheels and Rims for Pneumatic Tyres - Vocabulary, Designation and Marking
ISO 7141:2022	Road Vehicles - Wheels - Impact Test Procedure

2.1.3 Other Publications

AKR-LH-08	Wheels Requirements and Tests
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3. DEFINITIONS

The terminology used herein follows the standard definitions found in SAE J393 with the following additions:

3.1 STRIKE-THROUGH

When there is no air between the pinched tire sidewall and wheel flange.

3.2 ADJUSTED DROP HEIGHT (ADH)

The height, in millimeters (mm), that a mass must be dropped from to replicate free fall of a nominal drop height. The drop height is adjusted until free fall velocity is achieved at 0.4 m and 1.4 m as measured by time of 9.14 ms (tolerance of +0.3 ms) and 4.88 ms (tolerance of +0.3 ms), respectively, to pass through a distance of 25.4 mm prior to tire contact. Tests are to be conducted at adjusted drop height. See Appendix A for a recommended procedure for measuring mass velocity and adjusting drop height.

3.3 BEAD SEAT RADIUS WEATHER SIDE

The horizontal location from which the deformation is to be repeatably measured.

4. TEST PROCEDURES

4.1 Wheels for Test

Only fully processed new wheels, which are representative of wheels intended for passenger car and light truck applications, shall be used for each test. Tires and wheels used for test should not be used subsequently on a vehicle.

5. EQUIPMENT

The test stand capable of impact loading to the inner half of tire wheel assembly. The wheel shall be mounted with its spinning axis at 1 degree, such that the inner flange is above the outer flange. The impact striker shall be at least 250 mm wide such that the one end aligns with the center of the tire wheel assembly while the other end extends beyond the inner flange by 25 mm minimum.

5.1 Test Equipment Parameters

1. The impact striker = 90 degrees included angle ± 1 degree with radius $R2 = 25$ mm (± 2 mm) at the impact edge. Drop vertically. See Figure 2.
2. The wheel clamping should be rigid and yoked by a clevis at a distance of 200 mm. See Figure 3.
3. The right most edge of the striker is to be placed at the visual center of the tire and extend beyond the inner flange by 25 mm. See Figure 3.
4. Wheel support: Belleville spring stiffness $Cf = 85$ kN ± 5 kN, spring compression is to be restricted to 10 mm. See Figure 3.
5. Basic setting of the wheel clamping is 1 degree downward. See Figure 3.
6. The wheel must be able to rotate around its spinning axis, displace laterally, and lock the wheel during test. See Figure 2.
7. The striker is to be intercepted mechanically after the first impact; a second impact is to be prevented. Exception in case of wheel breaking and abrupt air loss. See Figure 3.
8. The mass of the load pack, load cells and striker to be 175 kg $\pm 2\%$.
9. Start the adjusted drop height at 0.4 m and increase in 0.2 m increments until air pressure loss of 50% in 30 seconds.
10. A method of measuring the deformation of the inner flange after impact. The deformation to be measured between the flange and the horizontal portion of the test stand that holds the wheel. See Figure 4. Find set measurement.
11. An optional method of measuring the velocity of the striker, just prior to impact of the tire. The velocity is used to determine energy when associating with millimeters of deformation. There are multiple ways to measure velocity, a few possibilities include a "gate and knife" system, high speed cameras, or a string pot linear displacement sensor.
12. An optional method of measuring dynamic forces exerted on the wheel-tire assembly by the striker.
13. Optional method of recording high speed video of the wheel and tire during impact.

14. Equipment calibration:

- a. The fixed (non-removable) carriage/striker mass should be calibrated once every 10 years
- b. The removable mass weights should be calibrated individually, once every 10 years if made from ferrous materials. Otherwise, if mass weights are made from softer materials, such as lead or aluminum, calibrate annually.
- c. All load cells used to calibrate equipment shall be traceable to the National Institute of Standards and Testing (NIST).
- d. The velocity sensor shall be calibrated once per year. All other calibration items shall be calibrated at least every 6 months.

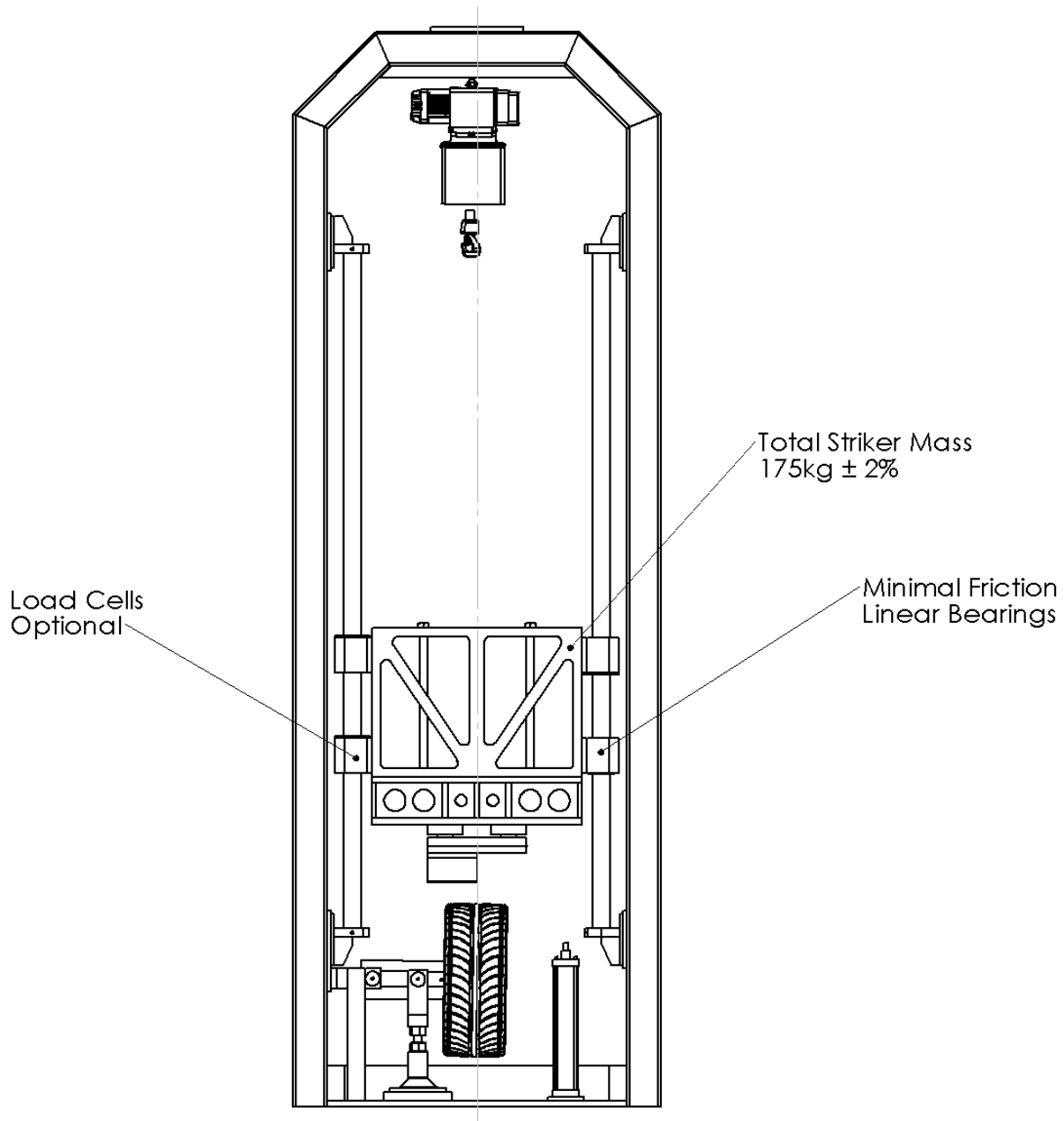


Figure 1 - Front view of radial impact test stand