INTERNATIONAL

Designation: F377 – 03 (Reapproved 2022)

Standard Practice for Calibration of Braking/Tractive Measuring Devices for Testing Tires[1]

This standard is issued under the fixed designation F377; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice gives procedures for the calibration of:

reference load cells

calibration platform systems by using a reference load cell

static calibration of braking/tractive force on locked wheels of tire test trailers, instrumented vehicles, and laboratory tire testing machines by using the calibration platform system as a calibration fixture.

1.2 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E74 Practices for Calibration and Verification for Force-Measuring Instruments

F538 Terminology Relating to Characteristics and Performance of Tires

3. Terminology

3.1 *Definitions:*

3.1.1 *bias, n*—the difference between the average measured test result and the accepted reference value; it measures in an inverse manner the accuracy of a test.

3.1.2 *longitudinal force, [F], of a tire, n*—the component of the tire force vector in the X' direction.

3.1.3 *vertical load, n*—the normal reaction of the tire on the road which is equal to the negative of normal force.

4. Summary of Practice

4.1 Reference-load cells shall be calibrated using procedures and equipment traceable to the National Institute of Standards and Technology (NIST), or appropriate national standards organization.

NOTE 1—Practice E74 may be used as an alternative method for load-cell calibration.

4.2 The calibrated reference-load cell is used to calibrate the calibration-platform systems or used as the longitudinal force sensor. The tire test trailer, instrumented vehicle, or laboratory tire testing machine is calibrated with the platform.

5. Significance and Use

5.1 Calibration is essential in the use of various test platforms and devices to insure that the test results generated by these test devices are accurate, repeatable and meaningful. This standard gives the necessary instructions for the calibration of all of the test devices cited in the Scope.

6. Apparatus

6.1 The calibration system consists of the following basic components:

6.1.1 *Platform*—The platform on which the test wheel is placed shall have a flat high friction top surface. The platform shall be of sufficient dimensions to support the entire tire contact patch throughout the calibration process. A low friction bearing (an air bearing is recommended) permitting free horizontal motion and capable of sustaining a vertical load equal to the largest anticipated wheel load shall support the platform. The longitudinal movement shall be sufficient to obtain the necessary required force levels. The platform may also be instrumented with integrated transducers (Force Sensors) to measure vertical and longitudinal forces.

[1] This practice is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.10 on Equipment, Facilities and Calibration.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

6.1.2 *Force Generation Apparatus*—A system, capable of developing a longitudinal force sufficient for the calibration of the operating range of the device, shall be used. The force shall be applied along the longitudinal centerline of the platform.

6.1.3 *Force Sensors*—Sensors to measure applied forces in the vertical and longitudinal directions that shall be used to calibrate braking/tractive measuring devices. These sensors can be integrated force transducers located in the platform, scales or tension load cells. Sensors shall have sufficient measurement range to cover the maximum anticipated test wheel forces. Sensors shall be mounted in a manner such that cross-axis forces will not adversely affect the accuracy. The force sensor instrumentation shall have the capability to allow for the recording of data, such as a chart recorder, data logger, or visual output that allows for manual logging of data.

6.1.4 *Reference Load Cell*—The force standard that provides direct traceability to NIST or appropriate national standards organization that shall be used to certify other force sensors or weights used within this standard. If integrated platform transducers are not used, the reference load cell may be used as the longitudinal force sensor during calibration of the braking/tractive measuring device. The reference load cell shall have sufficient measurement range to cover the maximum anticipated forces.

7. Calibration of the Reference Load Cell and Force Sensors

7.1 Three procedures are covered: *(1)* calibration of the reference-load cell, *(2)* calibration of the longitudinal force sensor, and *(3)* calibration of the vertical load sensor. Repeat the appropriate calibrations when any relevant component is changed or altered (see ASTM Manual 7). Repeat the calibrations annually unless the changes between the most recent calibration equation values and those from the previous calibration do not exceed 0.1%. Calibration intervals may be lengthened to a maximum of 2 years provided that these changes do not exceed 0.1% of the value. Record the ambient temperature during load cell calibrations. Force sensor gain values (or their equivalent) shall be consistent throughout sections 7.3 and 7.4.

7.2 *Reference Load Calibration:*

7.2.1 Set up the reference load cell, indicator and required equipment to perform the calibration. List all equipment used, including signal conditioning and output devices. Record equipment identification and calibration dates.

7.2.2 Set the bridge-excitation voltage and gain, or its equivalent, in accordance with the instructions on the unit being used.

7.2.3 Adjust the "bridge zero," or its equivalent, to "zero." Be certain that the reference load cell is not being stressed.

7.2.4 Using force measuring instruments or weights known to 0.01% or better of applied force, perform a calibration on the reference load cell. Class F weights of 8.9N (2 lb) or greater have a tolerance of 0.01%. Apply the calibration forces in at least 8 appropriately spaced increments to a maximum of not less than the anticipated maximum force seen in use. Allow all force indicators to come to rest at each increment and record the force readings.

7.2.5 Determine bias values at each applied force.

7.2.6 The biases of the reference-load cell and indicator system shall be 0.25% or less of the known applied force (minimum of ±2.2 N (±0.5lbf)).

7.3 *Calibration of Longitudinal Force Sensor* Fig. 1—Subsection 7.3 does not apply when the reference load cell is used as the longitudinal force sensor during calibration of the braking/tractive measuring device.

7.3.1 Mount the reference-load cell such that its longitudinal axis is parallel to the direction of motion of the platform within ±2° and in line with the applied force. If necessary, place a tension spring in the longitudinal force application system to allow for longitudinal motion.

7.3.2 Apply sufficient force to both channels of the system through the full range of expected calibration forces to exercise to platform. Release all forces.

7.3.3 Set the bridge-excitation voltage and gain, or its equivalent, for all instrumentation in accordance with the instructions on the unit being used.

7.3.4 Adjust the "bridge zeros," or its equivalent, to "zero" on all instrumentation. Be certain that the reference load cell and platform are not being stressed.

7.3.5 Using weights known to 0.1% of applied load or better, apply a test load, representative of a load which will be encountered on the braking/tractive test device to be calibrated, to the top of the platform near the geometric center of the top. The platform must be maintained level within ±0.25° during calibration. Record all force readings.

NOTE 2—The platform may be sensitive to the support structure used during calibration. Therefore during calibration, the platform shall be supported in a manner similar to that which will subsequently be used during the calibration of the braking/tractive measuring device.

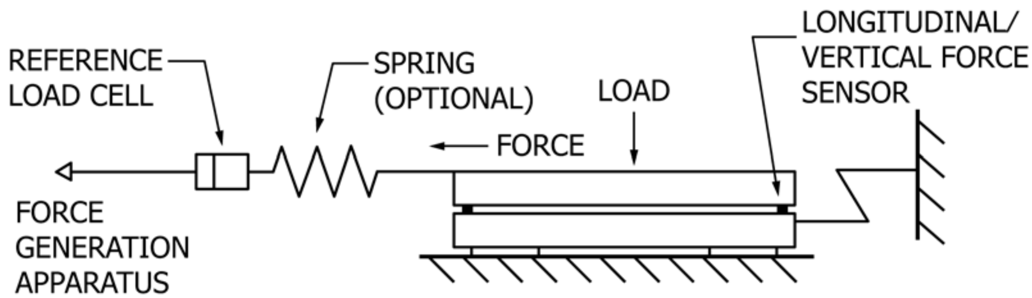

FIG. 1 Force Calibration of a Platform Force Transducer