Designation: D8360 − 22

Standard Test Method for Determination of Rutting Tolerance Index of Asphalt Mixture Using the Ideal Rutting Test[1]

This standard is issued under the fixed designation D8360; 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 test method covers the procedures for preparing, testing, and measuring asphalt mixture rutting resistance at high temperatures using cylindrical laboratory-prepared asphalt mix samples or pavement cores. The test method describes the determination of the rutting tolerance index, RT_{Index}, and other parameters determined from the load-displacement curve. These parameters can be used to evaluate the resistance of asphalt mixtures to rutting.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 The within-laboratory repeatability standard deviation of rutting tolerance index has been determined to be 2.42, based on two labs, 30 test replicates, and ten different samples. The between-laboratory reproducibility of this test method is being determined and will be available on or before December 31, 2026. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purpose.

1.5 *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.*

1.6 *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]

D8 Terminology Relating to Materials for Roads and Pavements

D979/D979M Practice for Sampling Bituminous Paving Mixtures

D3203/D3203M Test Method for Percent Air Voids in Compacted Asphalt Mixtures

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6925 Test Method for Preparation and Determination of the Relative Density of Asphalt Mix Specimens by Means of the Superpave Gyratory Compactor

D6926 Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus

D6927 Test Method for Marshall Stability and Flow of Asphalt Mixtures

2.2 *AASHTO Standards:*[3]

R 30 Practice for Mixture Conditioning of Hot Mix Asphalt (HMA)

T 324 Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures

T 340 Standard Method of Test for Determining Rutting Susceptibility of Hot Mix Asphalt (HMA) Using the Asphalt Pavement Analyzer (APA)

T 378 Standard Method of Test for Determining the Dynamic Modulus and Flow Number for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)

TP 116 Standard Method of Test for Rutting Resistance of Asphalt Mixtures Using Incremental Repeated Load Permanent Deformation (iRLPD)

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, refer to Terminology D8.

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.26 on Fundamental/Mechanistic Tests.

Current edition approved Oct. 1, 2022. Published October 2022. DOI: 10.1520/D8360-22.

[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.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 RT_{Index}, *n*—rutting tolerance index, the value used to evaluate mixture resistance to rutting.

3.2.2 P_{max}, *n*—peak load (kN). See 10.3.

3.2.3 τ_f, *n*—shear strength (MPa).

4. Summary of Test Method

4.1 The ideal rutting testing is conducted through the application of a monotonic compressive load along a vertical diametral plane of a cylindrical specimen of asphalt concrete centered in the testing apparatus. The load is applied such that an average constant load-line displacement (LLD) rate of 50.0 ± 2.0 mm/min is obtained and maintained for the duration of the test. Both the load and LLD are measured during the entire duration of the test and are used to calculate the RT_{Index}.

4.2 This test procedure considers both elastic/viscoelastic properties of the asphalt mix and its strain-hardening characteristics and is developed based on shear strength principle.[4]

5. Significance and Use

5.1 The ideal rutting test (IRT) is used to determine asphalt mixture rutting resistance at high temperature in the range of 50 ± 15 °C, depending on local climate. The specimens are readily obtained from Superpave Gyratory Compactor (SGC) compacted cylinders with a diameter of 150 ± 2 mm, with no cutting, gluing, drilling, or instrumentation required. Similarly, field cores with a diameter of 150 ± 2 mm can be tested to measure rutting resistance of in-place asphalt mixtures.

NOTE 1—Field cores may need cutting to a right thickness ranging from 38 mm to 95 mm. This test standard is not applicable to the specimens with a diameter other than 150 ± 2 mm, regardless of laboratory-compacted specimens or field cores.

5.2 The RT_{Index} of an asphalt mixture is calculated from the peak load (or shear strength). The RT_{Index} is a performance indicator of the rutting resistance of asphalt mixtures containing various asphalt binders, asphalt binder modifiers and additives, aggregate blends, fibers, and recycled materials. Generally, the higher the RT_{Index} value, the better the rutting resistance and consequently the smaller the rut depth in the field. Users can employ the RT_{Index} and associated criteria to identify rutting-prone mixtures during mix design and production quality control/assurance.

NOTE 2—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

6. Apparatus

6.1 *Test Apparatus*—An IRT test apparatus consists of an axial loading device, a load cell, one upper loading strip and lower supporting cradle, specimen deformation measurement devices, and a data acquisition system. Alternatively, the load cell, top loading strip and lower supporting cradle, specimen deformation measurement devices, data acquisition system, or combinations thereof can be integrated into a test fixture.

6.1.1 *Axial Loading Device*—The loading apparatus shall be capable of delivering loading in compression with a capacity of at least 15 kN. It shall be capable of maintaining an average constant deformation rate of 50 ± 2.0 mm/min. A hydraulic, an electromechanical, screw-driven, or a pneumatic loading frame may be used if it can maintain a displacement rate required to induce the average constant deformation rate of 50 ± 2.0 mm/min.

6.1.2 *Load Cell*—The load cell shall have a readability of 10 N and a capacity of at least 15 kN.

6.1.3 *Upper Loading Strip and Lower Supporting Cradle*—Steel loading and supporting cradle with a concave surface having a radius of curvature equal to the nominal radius of the test specimen. For specimens with a nominal diameter of 150 ± 2 mm, the upper loading strip shall be 19.05 ± 0.3 mm wide and the lower supporting cradle shall be as depicted in Fig. 1. The length of the loading strips shall exceed the thickness of the specimen by at least 5 mm. The outer edges of the bottom supporting cradle shall incorporate a fillet (Fig. 1) to remove sharp edges.

6.1.3.1 *Option A*—The loading strip and cradle can be part of a test fixture, similar to that shown in Fig. 1, in which the lower supporting cradle is mounted on a base having two perpendicular guide rods or posts extending upward. The upper loading strip shall be clean and freely sliding on the posts. Guide sleeves in the upper segment of the test fixture shall direct the specimen contact strip without appreciable binding or loose motion in the guide rods.

6.1.3.2 *Option B*—The loading strip and cradle can be part of a test fixture, similar to that shown in Fig. 2, in which the lower supporting cradle is mounted on the lower loading strip of an indirect tensile fixture with two perpendicular guide rods or posts extending upward. The upper loading strip shall be clean and freely sliding on the posts. Guide sleeves in the upper segment of the test fixture shall direct the specimen contact strip without appreciable binding or loose motion in the guide rods.

6.1.4 *Internal Displacement Measuring Device*—The displacement measurement acquisition system shall have a readability of 0.01 mm and a range sufficiently large to handle the expected total displacement during the test. The machine stroke linear variable differential transformer (LVDT) or other type of displacement transducer can be used if its resolution is sufficient to meet the requirement. The displacement data measured during the test may need to be corrected for system compliance through standardizing the test system.

6.1.5 *External Displacement Measuring Device*—If an internal displacement measuring device does not exist or has insufficient precision, one or more external displacement measuring devices such as LVDTs can be used.

[4] Zhou, F., Crockford, W., Zhang, J., Hu, S., Epps, J., and Sun, L., "Development of an IDEAL Rutting Test for Asphalt Mixture Design, Quality Control and Quality Assurance," *Journal of the Association of Asphalt Paving Technologists*, 2019.

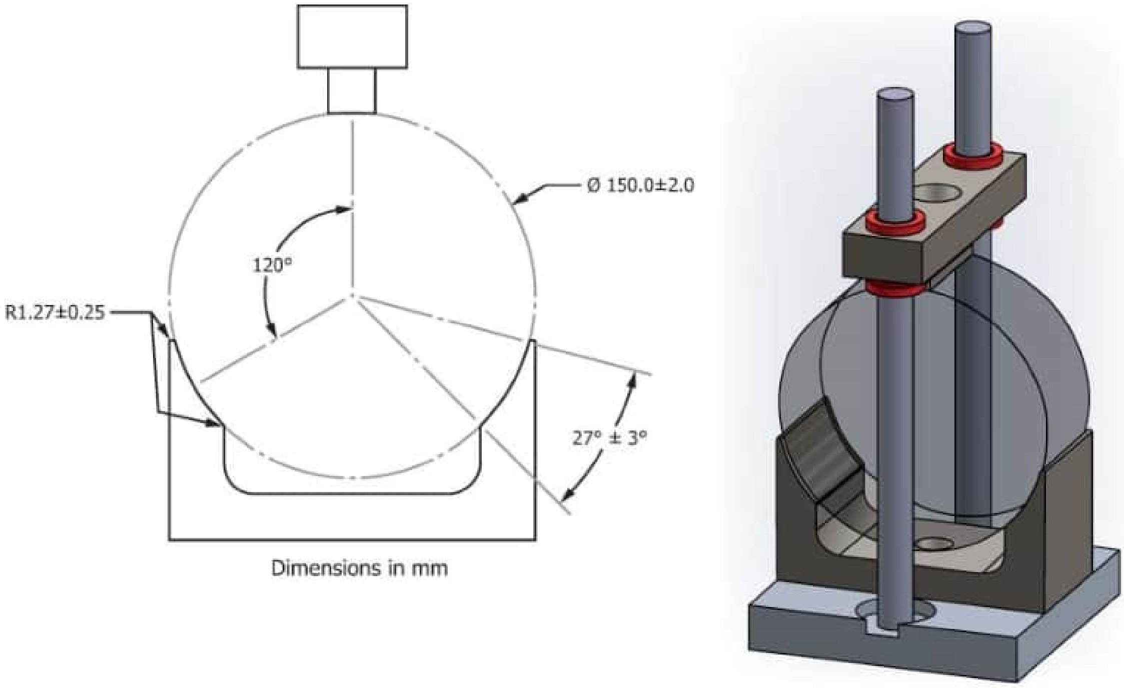

FIG. 1 Ideal Rutting Test Fixture—Option A

6.1.6 *Data Acquisition System*—Time, load, and LLD (using either internal or external displacement measuring devices) data are collected at a minimum of 40 sampling data points per second to obtain a smooth load-LLD curve.

6.2 *Conditioning Chamber*—An environmental chamber or water bath capable of maintaining the target high test temperature ± 1.0 °C for conditioning specimens before testing.

NOTE 3—The target high test temperature generally is in the range of 50 ± 15 °C.

6.3 *Gyratory Compactor*—A gyratory compactor and associated equipment for preparing laboratory specimens in accordance with Test Method D6925 are needed.

6.4 *Saw*—A laboratory saw capable of trimming field cores no less than 38 mm or cutting field cores thicker than 95 mm, if needed.

6.5 *Sample Measurement Device*—A caliper accurate to ±0.1 mm shall be used to measure specimen thickness and diameter.

7. Hazards

7.1 Standard laboratory caution should be exercised when handling, compacting, and fabricating test specimens and asphalt mixtures.

8. Sampling, Test Specimens, and Test Units

8.1 This rutting test may be conducted on laboratory-prepared test specimens or field cores. Sampling of the laboratory-prepared specimens shall follow the Practice D979/D979M standard procedure.

8.2 *Laboratory-Compacted Asphalt Mixture Samples:*

8.2.1 *Specimen Size*—For the mixes with a nominal maximum aggregate size (NMAS) of 19 mm or smaller, the specimens are 150 ± 2 mm in diameter by 62 ± 1 mm thick. For the mixes with a NMAS of 25 mm or larger, specimens are 150 ± 2 mm in diameter by 95 ± 1 mm thick. Test specimens are prepared without cutting or trimming and their perimeter surface shall be perpendicular to the top and bottom faces and not depart by more than 6 mm.

8.2.2 *Aging*—Laboratory-compacted test specimens shall be short-term aged before the compaction.

NOTE 4—For laboratory-mixed and laboratory-compacted (LMLC) mixes, loose mixes should be short-term aged for 2 h at compaction temperatures (AASHTO R 30) before the compaction. For plant-mixed and laboratory-compacted mixes (PMLC), specimens may be compacted after reheating the mix to its compaction temperature

8.2.3 *Compaction and Air Void Content*—Prepare a minimum of three specimens at the target air void content of 7.0 ± 0.5 %.

NOTE 5—A Superpave Gyratory Compactor according to Test Method D6925 is preferred for compacting test specimens, but other types of compactors (such as Marshall hammer according to Practice D6926) are allowed as long as the required dimensions of the test specimens are met. The specimen air voids can be calculated using Test Method D3203/D3203M.

8.3 *Samples Cored from Asphalt Pavements:*

8.3.1 Roadway cores can be used if pavement layer thickness is greater than 38 mm. Roadway core specimens shall be 150 ± 2 mm in diameter, and the core perimeter surface shall be perpendicular to the top and bottom faces and not depart by more than 6 mm. Trim bottom face of all cores and, if needed, trim the top face to the same thickness to ensure the cores are as thick as possible, while neither greater than 95 mm nor less

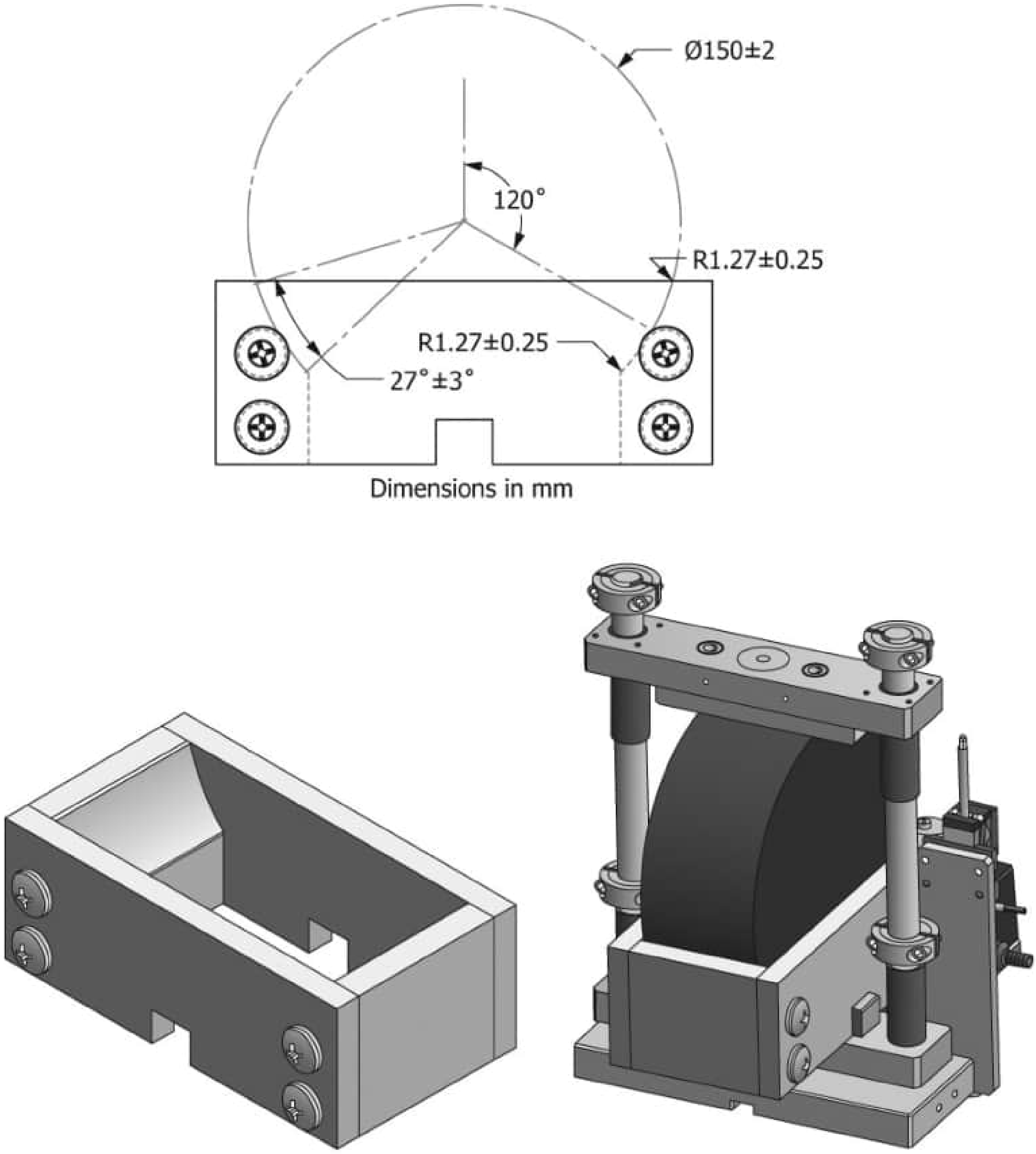

FIG. 2 Ideal Rutting Test Fixture—Option B

than 38 mm. Testing specimens at a uniform thickness will reduce test error. The air voids of the core specimens shall be determined.

NOTE 6—Care shall be taken to avoid damage to the cores during handling and transportation prior to testing. A core bit 156 mm in external diameter may be needed in order to obtain cores 150 ± 2 mm in diameter. For those cores with air voids different from 7 ± 0.5 %, the rutting tolerance index at 7 % air voids can be estimated, as detailed in Note 11.

8.4 A minimum of three specimens shall be tested for LMLC or PMLC specimens. A minimum of three roadway core specimens shall be tested.

9. Procedure

9.1 Precondition test specimens at a preselected target high test temperature ± 1.0 °C for 150 ± 10 min in an environmental chamber or 45 ± 5 min in a water bath in wet condition.

NOTE 7—The target high test temperature generally is in the range of 50 ± 15 °C. One can use the same test temperature as that of the Marshall stability test (Test Method D6927) or the Hamburg wheel tracking test (AASHTO T 324) or the asphalt pavement analyzer (AASHTO T 340) or the flow number test (AASHTO T 378) or incremental repeated load permanent deformation (iRLPD, AASHTO TP 116). Rutting resistance of asphalt mixtures depends on test temperature. The higher the test temperature, the poorer the rutting resistance of asphalt mixtures.

NOTE 8—Specimens can be tested in either dry or wet condition and the test results are not significantly different.

9.2 Inspect the fixture to ensure that all contact surfaces are clean and free of debris and then place the fixture into the load frame and verify proper setup of displacement measuring device.

9.3 Insert the specimen in the fixture, ensuring the specimen is centered and making uniform contact on the support. Generally, it is sufficient to center the specimen by eye.

9.4 Apply load to specimen in LLD control at a rate of 50 ± 2.0 mm/min. The test may be terminated 5 s after the peak load. During the testing, record the time, load, and displacement at a minimum sampling rate of 40 data points per second.

9.5 Testing shall be completed in 2 min or less after removal from the environmental chamber or water bath to maintain a uniform specimen temperature.

10. Calculation or Interpretation of Results

10.1 Shear strength of asphalt mixture is calculated from the measured maximum load, as listed below:

$$\tau_f = 0.356 \times \frac{P_{max}}{t \times w} \quad (1)$$

where:

τ_f = shear strength (Pa),
P_{max} = maximum load (N),
t = specimen thickness (m), and
w = width of upper loading strip (=0.0191 m).

NOTE 9—0.356 is a coefficient transferring maximum load to shear strength in Eq 1.

10.2 Rutting tolerance index (RT_{Index}) is calculated from the shear strength, as listed below:

$$RT_{Index} = 6.618 \times 10^{-5} \times \frac{\tau_f}{1\ \text{Pa}} \quad (2)$$

where:

RT_{Index} = rutting tolerance index, and
τ_f = shear strength calculated from Eq 1 (Pa).

NOTE 10—1 Pa is a unit cancelation factor and 6.618×10^{-5} is a scale factor in Eq 2.

NOTE 11—For the field cores having air voids different from 7.0 ± 0.5 %, the RT_{Index} at 7.0 % air voids can be estimated from Eq 3:

$$RT_{Index@7\%} = 0.446e^{0.11864AV} \times RT_{Index} \quad (3)$$

where:

$RT_{Index@7\%}$ = rutting tolerance at 7 % air voids,
RT_{Index} = rutting tolerance index calculated from Eq 2, and
AV = air voids of field core (%).

10.3 A load versus load-line displacement curve is shown in Fig. 3.

11. Report

11.1 The report shall include the following parameters for each test specimen:

11.1.1 Asphalt mixture type.
11.1.2 Test temperature, to the nearest 0.1 °C.
11.1.3 Specimen preparation method and aging condition.
11.1.4 Specimen air voids, to the nearest 0.1 %.
11.1.5 Specimen thickness, to the nearest 0.0001 m.
11.1.6 Specimen diameter, to the nearest 0.0001 m.
11.1.7 Peak load, P_{max}, to the nearest 0.1 N.
11.1.8 Shear strength, τ_f, to the nearest 1 Pa.
11.1.9 Rutting tolerance index, RT_{Index}, to the nearest 0.1.

12. Precision and Bias

12.1 The within-laboratory repeatability standard deviation of the RT_{Index} has been determined to be 2.42, based on two labs, 30 test replicates, and ten different samples. The between-laboratory reproducibility of this test method is being determined and will be available on or before December 31, 2026. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purpose.

12.2 No information can be presented on the bias of this procedure for measuring the rutting tolerance index because no material having an accepted reference value is available.

13. Keywords

13.1 asphalt mixture rutting resistance; ideal rutting test; rutting tolerance index

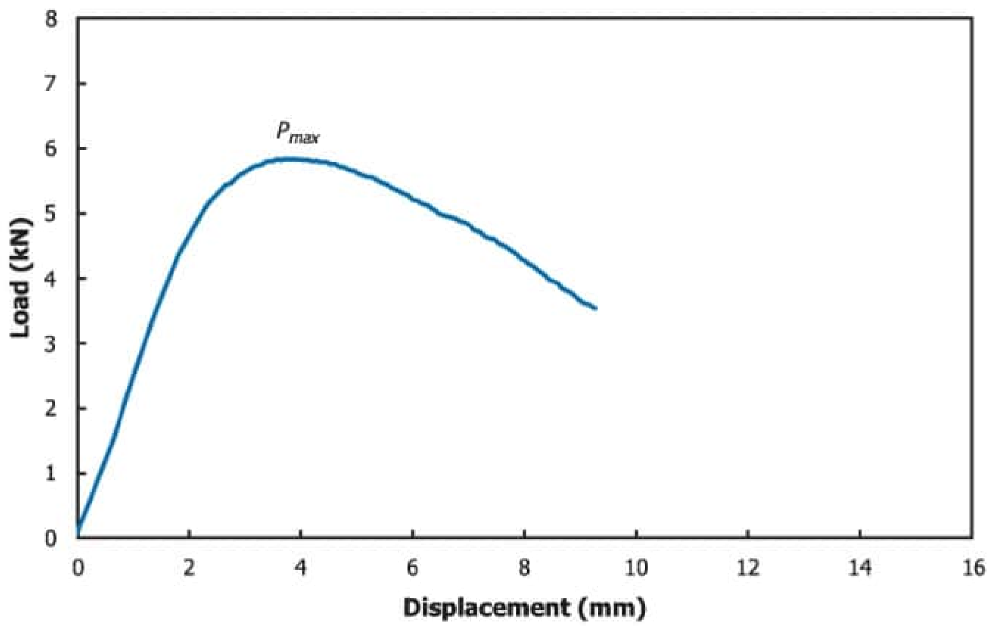

FIG. 3 Recorded Load (*P*) versus Load-Line Displacement (*l*) Curve