Standard Test Methods for Bicycle Forks[1]

This standard is issued under the fixed designation F2273; 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 These test methods describe mechanical tests for determining the following performance properties:

1.1.1 Compression Load,

1.1.2 Bending Load,

1.1.3 Impact Resistance, and

1.1.4 Bending Fatigue Life (followed by Impact Resistance).

1.2 The values stated in SI units are to be regarded as standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E4 Practices for Force Verification of Testing Machines

F2043 Classification for Bicycle Usage

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bicycle fork (fork)*—the mechanism between the head tube and the front axle, including the steerer tube, crown(s), shock absorbers, lower tubes, and upper tubes.

3.1.2 *steer tube*—the structural fork component typically housed inside the bicycle head tube, connected to the fork crown. The steerer tube transmits steering inputs from the rider to the fork and connects the fork to the bicycle frame by means of headset bearings.

3.1.3 *fork crown(s), or crown(s)*—the primary structural fork component responsible for connecting the steerer tube to the fork upper tube(s) or fork blades. Some suspension forks have an upper and a lower crown, while other forks have only one.

3.1.4 *dropout*—the fork component used to support the front wheel(s) at the axle(s).

3.1.5 *dropout centerline*—the front hub mounting axis that passes through both right and left dropouts.

3.1.6 *tire clearance*—the distance between the top surface of the tire and the bottom surface of the fork crown with no compressive force applied to the fork.

3.1.7 *crown-to-axle clearance*—the distance between the fork axle centerline and the bottom surface of the crown with no compressive load applied to the fork.

3.1.8 *head set*—the bearing cup, cones, and other supporting components for allowing rotation of the fork about the steering axis.

3.1.9 *limit trip or stop*—a deflection of the fork, which exceeds the allowable displacement values and causes the machine to stop running.

3.1.10 *suspension fork*—front fork incorporating compliance in the axial direction, parallel to the steer tube.

3.1.11 *rigid fork*—front fork that is not designed to be compliant in the axial direction.

4. Summary of Test Methods

4.1 *Compression Load Test*—In this test the fork is compressed in a direction parallel to the steerer tube. The distance from the bottom surface of the crown to the axle centerline is measured.

4.2 *Bending Load Test*—In this test the fork is restrained by the steerer tube and a load is applied in a direction perpendicular to the steerer tube axis, at the midpoint of the dropout centerline. The deflection is measured at the dropout centerline in a direction perpendicular to the steerer tube axis.

4.3 *Impact Resistance Test*—In this test a fork is fixtured with the steerer tube oriented horizontally, and supported by bearings. A weight is dropped from a prescribed height onto a fixture attached to the fork dropouts in line with the dropout centerline. Permanent deflection is measured at the dropout centerline in a direction perpendicular to the steerer tube axis. The ability of the connection between the steerer tube and

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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.

crown to support torque applied about the axis of the steerer tube is also evaluated.

4.4 *Fatigue Plus Impact Test*—In this test a fork is restrained by the steerer tube and a fully reversed load is applied in a direction perpendicular to the steerer tube axis at the midpoint of the dropout centerline. The test is suspended and the sample inspected if displacements exceed a prescribed value, or after the specified number of cycles, whichever comes first. If the test sample reaches the target cycle count, it is subsequently subjected to a frontal impact as described in 4.3. If inspection of the sample reveals a structural crack or fracture before reaching the target cycle count, or if the specified displacements during the cyclic loading are exceeded, the test is concluded and the number of cycles reached before failure is recorded.

5. Significance and Use

5.1 These tests are used to determine the conformance of a bicycle fork sample to a standard specified for each use classification.

6. Apparatus

6.1 *Compression Load Test:*

6.1.1 A fixture similar to Fig. 1 is required.

6.1.2 The load shall be applied to the top of the crown and along the centerline of the steerer tube (Fig. 1).

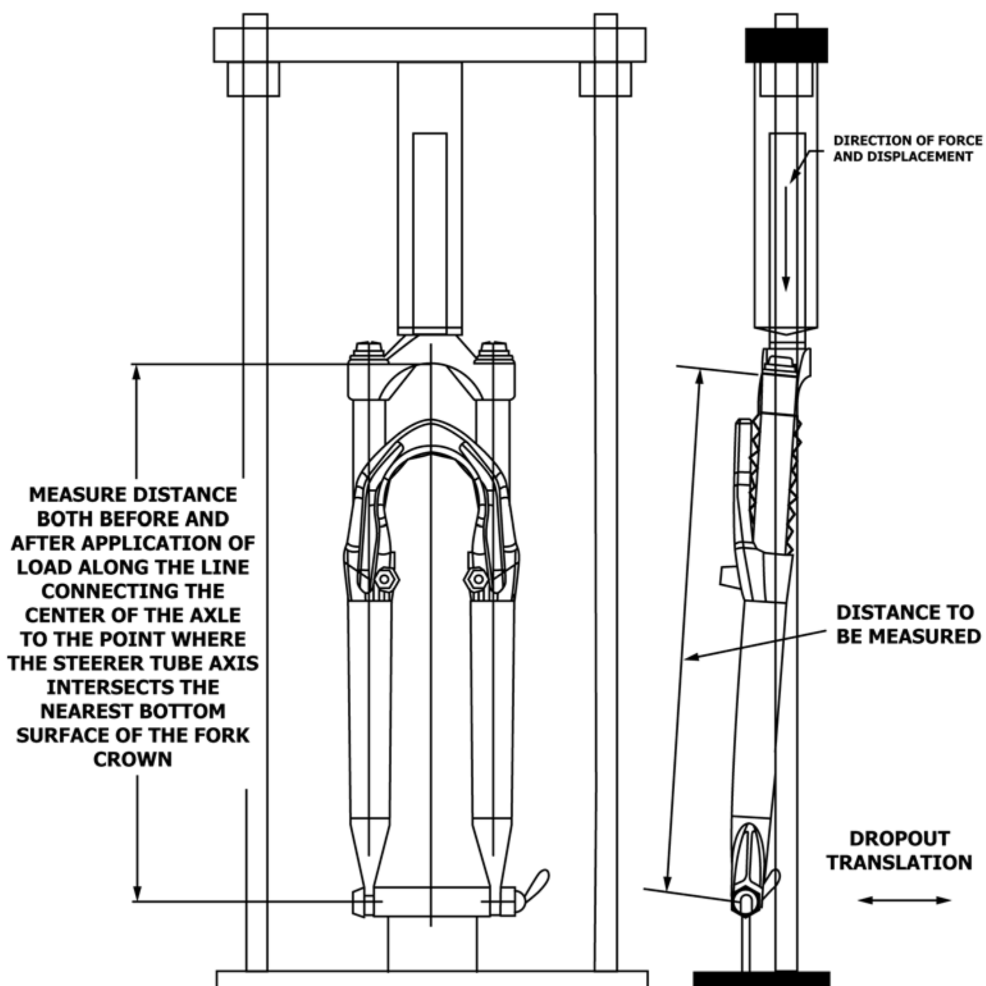
6.1.3 If necessary, either a roller or linkage system shall be used to allow translation of the dropouts while the fork is compressed.

6.1.4 The distance from the dropout centerline to the nearest surface of the crown on steerer tube centerline shall be measured (Fig. 1).

6.2 *Bending Load Test:*

6.2.1 A fixture similar to that shown in Fig. 2 is required to position a fork such that the steerer tube axis is horizontal and such that the fork is restrained by the steerer tube using standard headset bearings.

6.2.2 Bearing separation shall be 150 mm as shown in Fig. 2. Forks that require bearing installation not consistent with Fig. 2 shall be constrained in a manner consistent with their normal use.



NOTE 1—For some fork designs, a dropout support that allows translation may be required.

FIG. 1 Typical Compression Test Apparatus

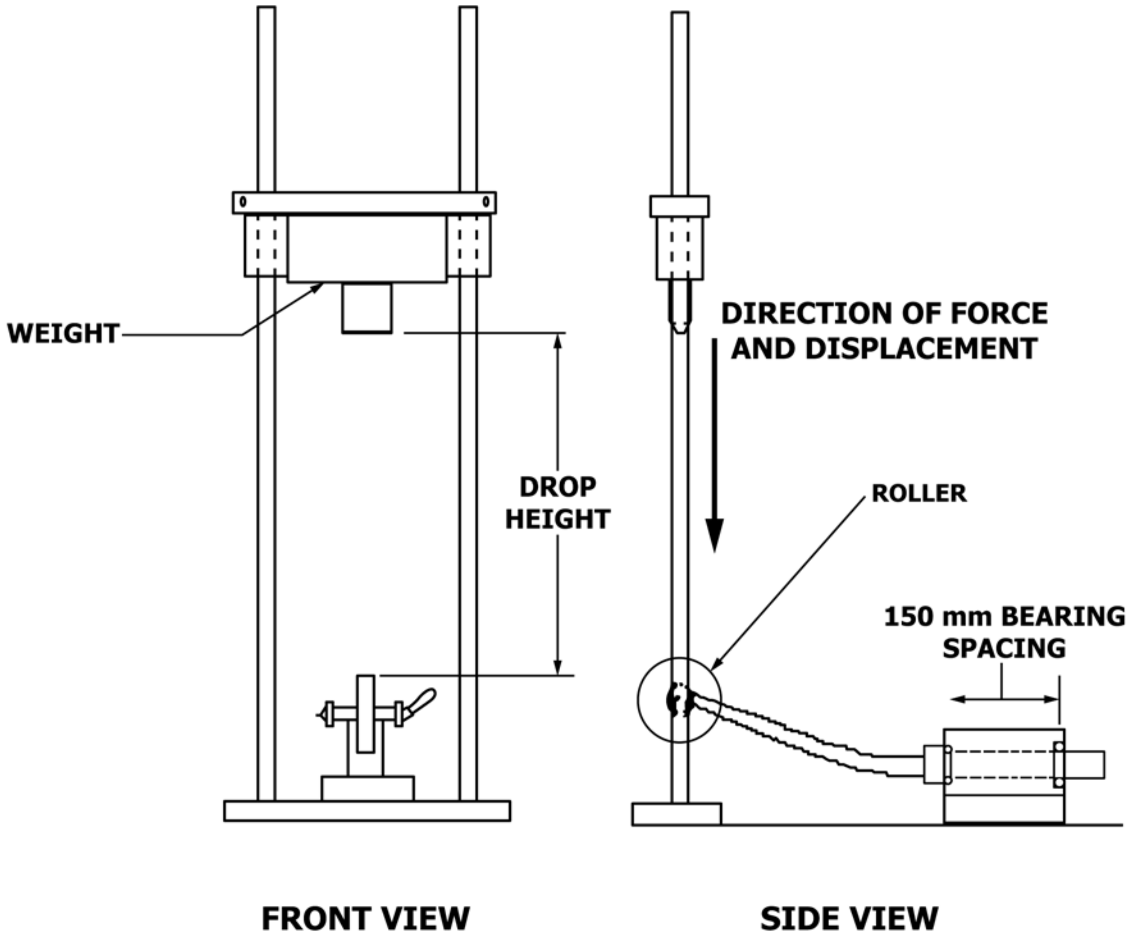


FIG. 2 Bending Load and Impact Test Setup

6.2.3 The load shall be applied at the dropout centerline in a direction perpendicular to the steerer (Fig. 2).

6.2.4 The dropout centerline shall be free to translate parallel to the steerer tube with either a roller or linkage system.

6.2.5 Deflection at the dropout centerline shall be measured perpendicular to the steerer tube.

6.3 *Impact Resistance Test:*

6.3.1 A fixture similar to that shown in Fig. 2 is required to position a fork such that the steered tube axis is horizontal and such that the fork is restrained by the steerer tube using standard headset bearings. The fork shall be constrained so that it cannot rotate about the steerer tube axis and the dropout centerline is maintained horizontal.

6.3.2 Bearing separation shall be 150 mm, as shown in Fig. 3. Forks that require bearing installation not consistent with Fig. 3 shall be constrained in a manner consistent with their normal use.

6.3.3 The application of the impact shall be perpendicular to the steerer tube axis at the midpoint of the dropout centerline (Fig. 2).

6.3.4 A roller shall be used (Fig. 2) and shall be of sufficient diameter to ensure that the impactor comes to rest on the roller following impact.

6.3.5 The height of the roller above the support base shall be such that the roller does not contact the base during the test. If the roller does contact the base during the test, the test shall be ruled invalid.

6.3.6 Deflection shall be measured at the dropout centerline in a direction perpendicular to the steerer tube axis.

6.3.7 An apparatus capable of checking whether the connection between the steerer tube and crown can support a prescribed torque applied to the steerer tube about its axis is also required.

6.4 *Fatigue Plus Impact Test:*

6.4.1 A fixture similar to Fig. 3 is required to support the fork by the steerer tube using bearings as shown.

6.4.2 Bearing separation shall be 150 mm as shown in Fig. 3. Forks that require bearing installation not consistent with Fig. 3 shall be constrained in a manner consistent with their normal use.

6.4.3 The force shall be applied at the dropout in a direction perpendicular to the axis of the steerer tube. An actuator that is capable of providing a fully reversed force of constant amplitude shall be used.

6.4.4 The dropout centerline shall be free to translate perpendicular to the direction of load application.

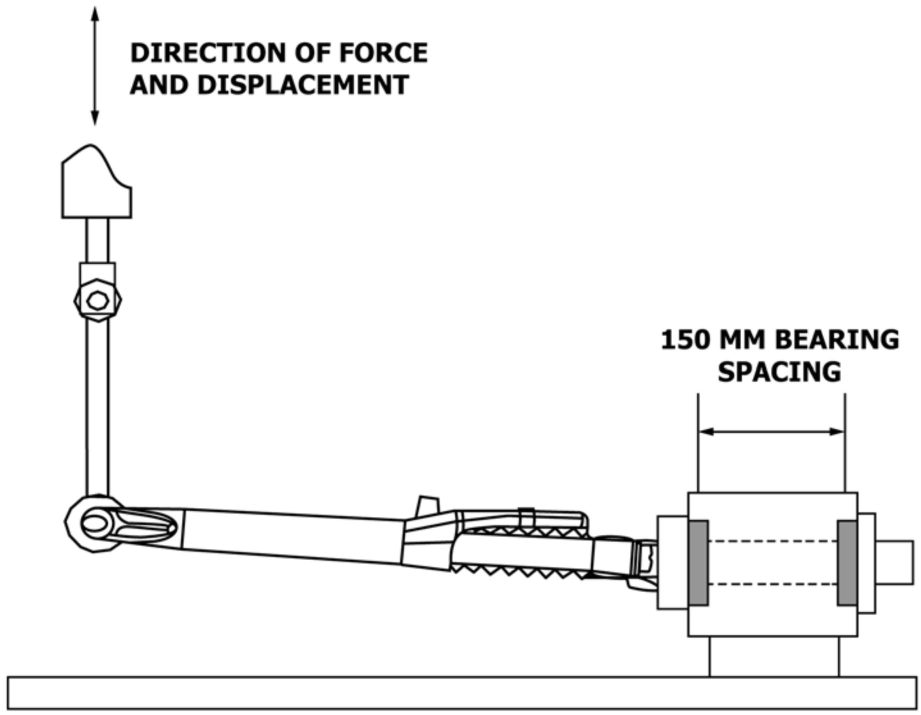


FIG. 3 Fatigue Test Setup

6.4.5 The ability of the actuator to produce the specified force shall be verified per Practices E4.

7. Test Specimens

7.1 *Preparation of Specimens*—The forks shall be set to the maximum fully extended length.

7.2 *Fork Adjustment:*

7.2.1 The fork shall be tested with the standard spring rate and all preload and damping shall be adjusted to the minimum settings.

7.2.2 All fasteners shall be assembled to manufacturer's specifications.

8. Calibration and Standardization

8.1 The direction of load application shall be within ±2°.

8.2 The accuracy of load application shall be within –0 % to +5 % of the specified value unless specified otherwise.

8.3 The accuracy of all distance and displacement measurements shall be within ±1 mm unless specified otherwise.

9. Conditioning

9.1 Tests are to be performed within the temperature range of 18 to 35°C.

9.2 All tests are to be performed on new forks with production stock settings except as noted.

10. Procedure

10.1 *Compression Load Test:*

10.1.1 Adjust spring preload and damping to the minimum settings.

10.1.2 Install fork into the compression fixture.

10.1.3 Measure the distance from the axle centerline to the nearest bottom surface of the crown on the steerer tube centerline and record.

10.1.4 Apply a specified compression load and hold for measurement.

10.1.5 Remeasure the distance from the dropout centerline to the bottom of the crown and record.

10.2 *Bending Load Test:*

10.2.1 Adjust spring preload and damping to the minimum settings.

10.2.2 Install the fork into the restraining fixture and adjust the preload on the headset bearings as installed normally.

10.2.3 Apply an initial load of 100 N. Zero the deflection measurement apparatus.

10.2.4 Apply an increasing load at a rate not to exceed 100 N/s until the specified bending load is obtained. If loading is to be applied manually using weights used, the weight must be applied in at least ten equal increments.

10.2.5 Measure the deflection at the dropout centerline between 60 to 90 s after the specified bending load is applied.

10.2.6 Remove the load until a load of 100 N is obtained.

10.2.7 Measure and record the change in fork deflection (permanent set) at the dropout centerline in a direction perpendicular to the axis of the steerer tube.

10.3 *Impact Resistance Test:*

10.3.1 Install the fork in the fixture using standard headset bearings. Constrain the steerer tube to prevent rotation of the fork in the bearings.

10.3.2 Install the roller in the fork.

10.3.3 Rest the weight on the roller.

10.3.4 Zero the deflection measurement apparatus at the dropout centerline, in the vertical direction.

10.3.5 Raise the weight to the first specified drop height (the distance between the bottom of the weight and the top of the roller, with no weight resting on the roller.

10.3.6 Release the weight, letting it freely fall and impact the roller. The weight will bounce on the roller until it comes to rest.

10.3.7 Measure and record the permanent deflection perpendicular to the steerer tube with the weight resting on the roller.

10.3.8 Repeat the impact on the same sample using the second specified drop height.

10.3.9 Check the connection between the steerer tube and crown by applying the specified torque about the axis of the steerer tube with the crown restrained. Record whether or not the steerer tube rotated in the crown and if so, then the torque value that initiated rotation.

10.4 *Fatigue Plus Impact Test:*

10.4.1 Install a typical headset into the Head Tube Apparatus (Fig. 3).

10.4.2 Install a typical headset crown race onto the fork.

10.4.3 Install the fork/crown race assembly into the head tube/headset assembly.

10.4.4 Adjust the headset using typical bicycle assembly practices. The bearings should allow free rotation of the fork without excess radial movement.

10.4.5 Connect the actuator mechanism to the fork dropouts according to the fork manufacturer's specification (Fig. 3).

10.4.6 Begin applying the specified fully reversed sinusoidal load at a frequency of 1 Hz. Stop the test after 1000 cycles and retighten all headset components. Restart the test and measure the peak displacements after 1000 cycles. If desired, then gradually increase the frequency until the running peak displacements are within ±3 % of the displacement at 1 Hz. Monitor the load to ensure an accuracy of –0 %, +5.0 % through either strain gages attached to the fork or a load cell. Monitor the displacement with an accuracy of ±5 %.

10.4.7 Conclude the test if an obvious structural failure is observed before 100 000 cycles, and report that the sample failed the test.

10.4.8 Interrupt the test if the running displacements (in either direction) increase by 40 % for suspension-type forks or 20 % for rigid forks, relative to the displacements recorded after the initial 1000 cycles of operation. Inspect the sample for structural cracks or fracture. If any are found, conclude the test, record the cycle count, and report that the sample failed the test. Cracks in paint or clearcoat do not indicate a structural failure. If no structural cracks or fractures are found, continue the test to complete 100 000 cycles, provided that the displacements remain within the limits of 40 % for suspension forks or 20 % for rigid forks.

10.4.9 Stop the test after 100 000 cycles. Inspect the sample carefully for structural cracks or fractures. Record and report these observations.

10.4.10 If the sample completes 100 000 cycles without exceeding the displacement limits noted above, and if no structural cracks or fractures can be observed, perform the impact resistance test described in 10.3, using the appropriate drop height for the specified classification.

10.4.11 Inspect the sample carefully for structural cracks and record all observations.

10.4.12 A passing result is obtained if the fork meets the specified requirements for the impact test following an impact from the specified drop height.

10.4.13 If the machine is shut down for any reason other than a displacement limit trip during the test, then no settings should be changed when the test is resumed.

11. Report

11.1 A test report shall be prepared to include the following:

11.1.1 Applicable Test Method Specification,

11.1.2 The manufacturer of the fork(s) tested,

11.1.3 The model, year, and serial number of the fork(s) tested,

11.1.4 The date and location of the test,

11.1.5 The name of the person and entity conducting the test,

11.1.6 A description of all instruments used to make load and distance or displacement measurements including identifying information such as the serial number or model number, or both,

11.1.7 Either the calibration record or a reference to such a record of all instruments used to make load and displacement measurements,

11.1.8 All measurements and observations required by the test method and the results of those measurements, and

11.1.9 A detailed description of any failure including the specific component that failed and the location of failure.

12. Rationale

12.1 The compression test was created for suspension forks to ensure that if structural components fail during high compression loads, the tire will not contact the fork crown. Although this test is primarily for suspension forks, this test should be conducted on all forks since rigid forks can fail under high compression loads as well.

12.2 The bending test was created to ensure that a fork can withstand the specified bending load developed during a nonimpact situation. In such a situation, the fork should neither permanently deform nor fracture as a result of normal riding loads.

12.3 The impact test was created to ensure a minimum energy absorbing capacity of a fork without fracture when encountering impact loads that could occur during either intended or unintended bicycle manoeuvres. The fork should permanently deform a specified amount as it absorbs impact loads without having any components either break or separate. The test to check for torque supported by the steerer tube is intended to ensure that a loss of steering control would not result from an impact that may have compromised the integrity of the crown-steerer tube joint.

12.4 The fatigue test was created to ensure that a fork can tolerate a specified number of repetitive load cycles without component failure as indicated by the formation of cracks. Because riding over paved or unpaved surfaces can develop repeated time varying loads as a result of inertial accelerations imposed by surface irregularities, assuring a specified lifetime in a fatigue environment is important to maintaining the structural integrity of the fork. The impact test following the fatigue test is intended to evaluate the impact resistance of the fork at the end of its normal life, since some structural failures may be difficult to clearly identify during the fatigue test. This is particularly true for forks which are made in whole or in part from composite structures, but this test can equally be used for forks made only from metallic components.

13. Precision and Bias

13.1 No precision or bias statements are included because these tests do not produce continuously variable outputs – they produce a pass or fail decision only.

14. Keywords

14.1 bending load test; bicycle forks; compression load test; fatigue test; impact resistance test