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An American National Standard

Standard Test Method for Determining the Force-Draw and Let-Down Curves for Archery Bows[1]

This standard is issued under the fixed designation F 1832; 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 procedure to be used to determine the force-draw and let-down curves for archery bows.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.3 *This standard does not purport 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. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *AMO (archery manufacturers and merchants organization) draw length*—the perpendicular distance from the point where the shooting string of the bow contacts bottom of the nock slot of the arrow, to a vertical line through the pivot or low point of the hand grip (draw length pivot point), plus a standard dimension of 1 3/4 in. (44.5 mm).

2.1.2 *brace height*—the dimension in inches (millimetres), from the grip pivot point (low point) of the grip to the nearest side of the bowstring, measured perpendicular to the bowstring, with the bow strung and in the undrawn condition.

2.1.3 *compound bow*—a type of bow that imposes a secondary system of control of the force-draw characteristic on the usual limb geometry control system of the conventional bow. This secondary control system can be composed of cam, levers, cables, or other elements, and combinations thereof. The dual control system permits great versatility in the design of the force-draw characteristic, and simplifies the inclusion of let-off. In general, it is normal for compound bows to have greater stored energy than conventional bows for a given level of peak or maximum draw weight.

2.1.4 *draw*—to move the shooting string of a bow from the rest or braced position toward the full drawn position by applying force to said string. Such action causes the limbs of the bow to bend and store energy. Moving the string from brace height to the full draw position corresponds to the draw stroke of a bow.

2.1.5 *draw cycle*—the combination of the draw-stroke and the power-stroke, resulting in a full cycle from brace height to full draw and return to brace height.

2.1.6 *draw-stroke*—the distance in inches (millimeters) from brace height to full draw.

2.1.7 *force-draw curve*—the curve that is plotted using the force readings, taken at incremental values of draw length when drawing the bow, as the ordinate and the corresponding draw length as abscissa.

2.1.8 *full draw*—the position assumed by the bowstring when the bow is drawn to a draw length corresponding to that from which it will be released for the shot. For most standard test purposes full draw is specified as 30 in. (762 mm) AMO draw length for compound bows, and 28 in. (711.2 mm) AMO draw length for non-compound bows, but it can take any assigned value.

2.1.9 *let-down curve*—curve that is plotted using the force readings, taken at incremental values of draw length when relaxing the bow, as the ordinate and the corresponding draw length as abscissa.

2.1.10 *let-off*—the difference between the peak or maximum draw force reached during the draw stroke of a bow, and the lowest level of draw force reached subsequent to that peak. Quantitatively, it is most frequently expressed as a percentage of the peak force and is then referred to as percent of let-off.

2.1.11 *non-compound bow*—a bow constructed in the traditional manner, having two flexing limbs extending outwardly in opposite directions from a handle. A single shooting string of a length shorter than the bow, connects the extreme ends of the limbs causing them to assume a pre-stressed flexed condition. Drawing the bow causes additional bending and stressing of the limbs, storing the energy necessary to propel the arrow. Control of the force-draw characteristic of the bow is exercised entirely by the static and dynamic geometry of the flexing limbs and the bowstring.

[1] This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.16 on Archery Products.

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2.1.12 *peak draw force*—the maximum force reached when drawing a bow. For conventional bows, the peak draw force is usually reached at the full draw condition. For compound bows, the peak draw force is reached part way through the draw, usually from about 35 to 75 % of the length of the draw stroke.

2.1.13 *power-stroke*—the distance in inches (millimetres) from full draw to brace height.

2.1.14 *static hysteresis*—The difference in pounds (newtons), measured under static conditions, between the draw force and the let-down force for any given draw length. Integrated over the full power-stroke of the bow, the static hysteresis is expressed as foot-pounds (joules) of energy.

2.1.15 *stored energy*—the energy required to draw a bow from brace height to full draw, usually expressed in foot-pounds (joules).

3. Significance and Use

3.1 This test method establishes the procedure to be used to measure the force necessary to draw an archery bow from brace height to the full draw position, and the holding force necessary to retain the bow string when the bow is let-down from full draw to brace height. The force values taken at increments of draw length (usually 1.0 in. (25.4 mm)) are then plotted versus draw length using rectangular coordinates. The resulting curves are known as the force-draw curve and the let-down curve.

3.2 The force-draw curve is used to determine the energy that the limbs of the bow store when it is drawn. The area under the curve between the positions of brace height and full draw can be expressed as stored energy.

3.3 The let-down curve is used to determine the energy required to restrain the bowstring as the bow is let-down from full draw to brace height. The energy represented by the area under the curve can be subtracted from the stored energy in order to establish the static hysteresis of the bow system.

4. Apparatus

4.1 *Force-Draw Machine*—A device capable of holding the bow with the restraining force located at the low point of the grip while the bowstring is drawn from brace height to full draw. The force drawing the bowstring shall be positioned near the center of the bowstring so the restraining and drawing forces balance, thus stabilizing the bow during the operation. The device contacting the bowstring shall be a round or radiused section with a radius of 1/8 in. (3.2 mm). The system used to draw the bowstring shall be capable of a smooth and steady movement, and must maintain continuous unrelaxed force so that no hysteresis effect is experienced.

4.2 *Force-Reading Device*—A scale or load cell shall be interposed between the bowstring and the cable or rod used to draw the bowstring so that the force reading is direct and not contaminated in any way. The force measuring device shall be capable of weighing to 0.25 lbf (1.12 N). A spring scale with adequate resolution may be capable of measuring the drawing force for conventional bows but will provide questionable values when used for compound bows with precipitous let-off.

4.3 *Draw Length Scale*—A graduated scale at least 36 in. (914.4 mm) in length having commercial accuracy shall be used to measure the draw length. It shall be indexed at a point 1 3/4 in. (44.5 mm) forward of the low point or pivot point of the grip.

5. Procedure

5.1 Adjust the bow to the desired peak draw force and draw length. On most conventional bows it will not be possible to adjust draw force and draw length, however the bowstring length should be twisted or untwisted to provide the recommended brace height.

5.2 To derive data for the force-draw curve, mount the bow in the force-draw device with the low or pivot point of the grip engaging the retaining surface of the device. Set the index of the linear scale 1 3/4 in. (44.5 mm) forward of the low point of the grip. Attach the drawing device to the bowstring at a location near the center of the string, position the bowstring at brace height, and draw the bow to the first incremental value of draw length. Record the force without relaxing tension to eliminate any effect of hysteresis. Continue to draw the bowstring, recording the force for each increment of draw length until reaching one increment beyond the desired full draw position. The recorded data will be the basis of the force-draw curve.

5.3 To obtain the data for the let-down curve, relax the force retaining the bowstring until it returns to the full draw position and record the corresponding force. It will be somewhat lower than the force recorded when the bow was drawn to the same position. The difference is the level of static hysteresis present. Continue to back down the bowstring, recording the force readings at the identical increments of draw length used when the force-draw curve was established. Do this until the bowstring has returned to brace height. The recorded force levels and the corresponding draw length values are the data for the let-down curve.

5.4 The force-draw and let-down curves are plotted on rectangular coordinate scales with the force values as the ordinate and the draw length values as the abscissa. It is common practice to superimpose the let-down curve on the force-draw curve. The area under the curves may be determined by any acceptable method. With appropriate conversion, it is usually expressed in units of energy, for example, foot-pounds (joules).

6. Precision and Bias

6.1 *Precision*—The precision of this test method for determining the force-draw and let-down curves and the values of the energy represented is being determined.

6.2 *Bias*—No statement on bias is being made at this time because no data is available on which to base an evaluation of bias.

7. Keywords

7.1 brace-height; compound bow; draw-stroke; force-draw; let-down