ANSI/ASAE S459 MAR1992 (R2017)
Shear and Three-Point Bending Test of Animal Bone

American Society of Agricultural and Biological Engineers

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Shear and Three-Point Bending Test of Animal Bone

Developed by the ASAE Physical Properties of Agricultural Products Committee: approved by the ASAE Food and Process Engineering Institute Standards Committee; adopted by ASAE March 1992; approved as an American National Standard February 1993; revised editorially and reaffirmed by ASAE December 1996; reaffirmed by ANSI March 1998; reaffirmed by ASAE December 2001, January 2007; reaffirmed by ANSI January 2007; reaffirmed by ASABE January 2012; reaffirmed by ANSI February 2012; reaffirmed by ASABE January 2017.

Keywords: Animal, Bone, Test

1 Purpose

1.1 This Standard is designed for use in determining the mechanical properties of animal bones such as the ultimate shear strength, ultimate bending strength, apparent modulus of elasticity, and fracture energy.

2 Scope

2.1 Shear and bending tests of intact animal bones provide an objective method for evaluating the effects of age, sex, nutrition, contaminants, and environment on the physical condition of the animal.

2.2 Understanding the problems encountered in evaluating the mechanical properties of animal bones and attempting to compare the results of previous investigators, has led to the need for a standard procedure for testing, data interpretation, and reporting of results.

2.3 The type of test selected, shear or three-point bending, will be dependent on the size and shape of the bone. The three-point bending tests should be used only when the bone is straight, has a symmetrical cross section, and has a support length to diameter ratio greater than 10. The shear test is good for any size or shape of bone.

2.4 Determination of the shear or bending properties of animal bone requires the development of a force-deformation curve. From a shear force-deformation curve, ultimate shear force, ultimate shear strength (stress), and fracture energy can be obtained. From a bending force-deformation curve, ultimate bending force, deformation to fracture, ultimate bending strength (stress), apparent modulus of elasticity, and fracture energy can be obtained. Any of these mechanical properties can be used for the purpose of evaluation, and it is recommended that more than one property be used.

3 Definitions

3.1 Force: Fracture load applied to the test specimen.

3.2 Deformation: Amount specimen deflects under load.

3.3 Force-deformation curve: A graph (see Figure 1) with values of deformation on the abscissa and values of force on the ordinate.

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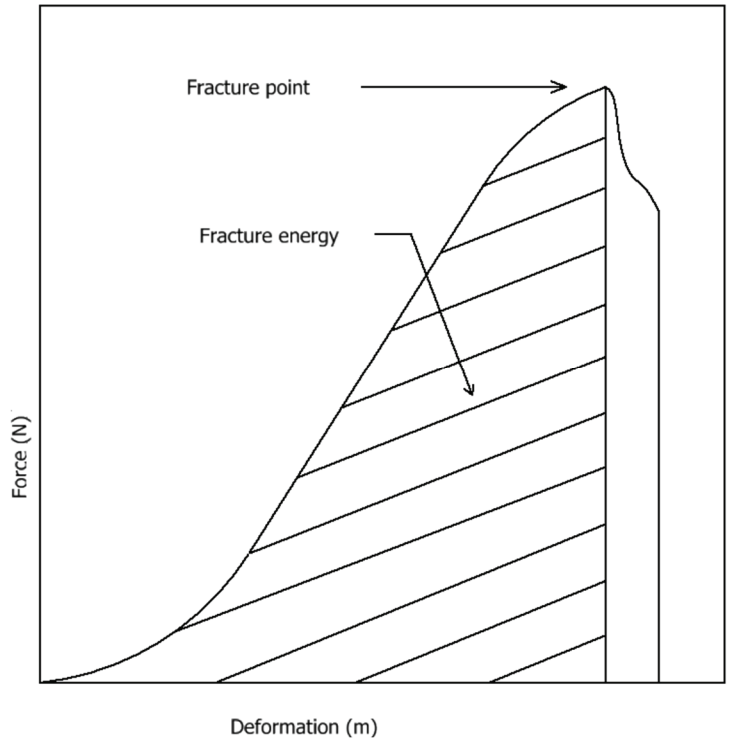

Figure 1 – Force deformative curve

3.4 Ultimate shear strength: Maximum shear stress that can be sustained by a material before rupture caused by a shear load.

3.5 Ultimate bending strength: Maximum bending stress developed in a material before rupture caused by a flexural load.

3.6 Fracture energy: The energy required to deform a material to the point of fracture. It is the area under the force-deformation curve up to the point of fracture (see Figure 1).

3.7 Stress-strain diagram: Graph of stress as a function of strain which is constructed from data taken from the force-deformation curve.

3.8 Modulus of elasticity: The slope of the straight line portion of a stress-strain diagram.

3.9 Apparent modulus of elasticity: When a material is inelastic (bone), loading and unloading the material several times within the linear limit may produce loading and unloading curves that may give different values for the modulus of elasticity. The apparent modulus of elasticity is the value of the modulus calculated from the first loading cycle (see ASAE Standard S368, Compression Test of Food Materials of Convex Shape).

4 Apparatus

4.1 Testing machine. Any testing machine capable of applying a constant rate of crosshead movement with the following:

4.1.1 A driving device for the crosshead with a reproducible speed with and accuracy of ±1.0%.

4.1.2 A force-deformation indicating mechanism (*x-y* plotter, chart recorder, data acquisition unit, etc.). The mechanism must be calibrated before testing. The testing machine should be periodically verified following ASTM Standard E-4, Practices for Load Verification of Testing Machines.

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