



Standard Test Method for Tensile Strain-Hardening Exponents (n -Values) of Metallic Sheet Materials¹

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INTRODUCTION

This test method for determining tensile strain-hardening exponents n utilizes stress-strain data obtained in a uniaxial tension test. Tensile data are obtained in a continuous and rate-controlled manner via displacement or strain control. The strain-hardening exponents are determined from an empirical representation over the range of interest of the true-stress versus true-strain curve. The mathematical representation used in this method is a power curve (Note 1) of the form **(1)**²:

$$\sigma = K\epsilon^n$$

where:

- σ = true stress,
- ϵ = true plastic strain,
- K = strength coefficient, and
- n = strain-hardening exponent

1. Scope

1.1 This test method covers the determination of a strain-hardening exponent by tension testing of metallic sheet materials for which plastic-flow behavior obeys the power curve given in the Introduction.

NOTE 1—A single power curve may not fit the entire stress-strain curve between yield and necking. If such is the case, more than one value of the strain-hardening exponent can be obtained **(2)**.

1.2 This test method is for metallic sheet materials with thicknesses of at least 0.005 in. (0.13 mm) but not greater than 0.25 in. (6.4 mm).

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents shown may be approximate.

1.4 *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.*

¹ This test method is under the jurisdiction of ASTM Committee E-28 on Mechanical Testing, and is the direct responsibility of Subcommittee E28.02 on Ductility and Flexure.

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² The boldface numbers in parentheses refer to the list of references appended to this method.

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines³
- E 6 Terminology Relating to Methods of Mechanical Testing³
- E 8 Test Methods for Tension Testing of Metallic Materials³
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁴
- E 83 Practice for Verification and Classification of Extensometers³
- E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods⁴

3. Terminology

3.1 Definitions:

3.1.1 The definitions of terms given in Terminology E 6 shall apply, with the addition of the following special terms used in this method.

3.1.2 *engineering strain (e)*—a dimensionless value that is the change in length (ΔL) per unit length of original linear dimension (L_0) along the loading axis of the specimen; that is, $e = (\Delta L)/L_0$.

3.1.3 *engineering stress (S)* [FL^{-2}]*—the normal stress, expressed in units of applied force, F , per unit of original cross-sectional area, A_0 ; that is, $S = F/A_0$.*

3.1.4 *necking*—the onset of nonuniform or localized plastic deformation, resulting in a localized reduction of cross-sectional area.

3.1.5 *strain-hardening (n)*—an increase in hardness and strength caused by plastic deformation.

³ Annual Book of ASTM Standards, Vol 03.01.

⁴ Annual Book of ASTM Standards, Vol 14.02.

