Designation: D6026 – 21

Standard Practice for Using Significant Digits and Data Records in Geotechnical Data[1]

This standard is issued under the fixed designation D6026; 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 Using significant digits in geotechnical data involves the processes of collecting, calculating, and recording either measured values or calculated values (results) or both. This practice is intended to promote uniformity in recording significant digits for measured and calculated values involving geotechnical data.

1.2 The guidelines presented are industry standard and are representative of the significant digits that should be retained in general. The guidelines do not consider material variation, the purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives, and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations.

1.3 It is beyond the scope of this practice to consider significant digits used in analysis methods for engineering design.

1.4 This practice accepts a variation of the traditional rounding method that recognizes the algorithm common to most hand-held calculators and computers, see 6.2.3. The traditional rounding method (see 6.2) is in accordance with Practice E29, ASTM Manual 7, or IEEE/ASTM SI 10.

NOTE 1—Calculators and computers often present and use many digits in their output and calculations, which may not all be significant. It is the responsibility of the programmer and user to make sure that the measured and calculated values are handled, interpreted and reported properly using these guidelines.

1.5 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process.*

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]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2435/D2435M Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

D4186/D4186M Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E456 Terminology Relating to Quality and Statistics

E833 Terminology of Building Economics

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): *The Modern Metric System*

MNL7 ASTM Manual 7 on Presentation of Data and Control Chart Analysis

3. Terminology

3.1 *Definitions*—For common definitions of soil and rock terms in this standard, refer to Terminology D653.

3.2 This terminology standard contains many definitions that are applicable to this standard in a grouping named Measurement Grouping. These terms are: accuracy, bias, estimation, meaningful number/digit or significant number/digit, observation/observed value or data point/recorded value, precision, resolution or readability, sensitivity, signal noise or noise.

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rockand is the direct responsibility of Subcommittee D18.91 on Standards Development and Review.

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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.

***A Summary of Changes section appears at the end of this standard**

3.3 Other definitions that are relevant to this topic of data management or presentation or both are given below.

3.4 *Definitions:*

3.4.1 *significant digit/number/figure, n*—any of the integers one through nine and zeros except leading zeros and some trailing zeros.

3.4.1.1 *Discussion*—Zero is a significant digit if it comes between two non-zero integers.

3.4.1.2 *Discussion*—Zeros, after a decimal point and leading the first nonzero digit of a number, indicate the order of magnitude only and are not significant digits. For example, the number 0.0034 has two significant digits.

3.4.1.3 *Discussion*—Zeros trailing the last nonzero digit for numbers represented with a decimal point are significant digits. For example, 4.00 and 4.01 have three significant digits.

3.4.1.4 *Discussion*—The significance of trailing zeros for numbers represented without the use of a decimal point can only be identified from a knowledge of the source of the value.

3.4.2 *sensitivity analysis, n*—a test of the outcome of an analysis by altering one or more parameters from an initially assumed or initial test value(s).

3.4.2.1 *Discussion*—Sensitivity analyses are often related to the design process, but not exactly applied in that design process. A sensitivity analysis might include how measured shear strength or hydraulic conductivity varies with molding water content or percent compaction, or both.

3.4.3 *test result, n*—the value obtained by applying a given test method, expressed as a single measurement or a specified combination of a number of measurements, calculations, or any combination.

3.4.4 *variability analysis, n*—the determination of the variation in test results or property values (index or engineering) within a given boundary condition(s).

3.4.4.1 *Discussion*—A variability analysis might include how a given property varies with depth.

3.5 Data Processing Grouping, the following four definitions cover how one should cover the collection or processing of test data.

3.6 *Definitions:*

3.6.1 *measurement or measured value, n*—the act or process of quantifying a physical measurement; such as time, acceleration, dimension (length, diameter, depth, and circumference), force, mass, pressure, and velocity. This process would also include in many test methods the calculation of basic quantities which do not require any judgment, such as water content, void ratio, density, unit weight, stress, and strain. See *read or reading* and determination.

3.6.1.1 *Discussion*—A typical example is: "Measure and record the height, diameter, and mass of the test specimen and calculate its density, in accordance with the requirements specified in this standard. or simply state Measure the density or water content." However, in some standards, the apparatus specified internally makes the necessary measurements and calculations and displays a test result(s), such as a nuclear gauge. In such cases, an example is: "Measure and record the total density and water content using a nuclear gauge meeting the requirements specified in the apparatus section of this standard."

3.6.2 *read or reading(s), n*—the act or process of quantifying an instrument(s); such as dial gauge, burette, multimeter, transducer, or data acquisition system. See observation/observed value or data point/recorded value, mentioned above in 3.2.

3.6.2.1 *Discussion*—A typical example is: "Read and record the dial gauge measuring the change in the height of the test specimen during consolidation at time intervals and meeting the requirements specified in this standard." For usage of a data acquisition system: "Read and record, at intervals specified in this standards the transducer's measuring the applied axial force, axial displacement, and cell pressure applied to the test specimen along with the internal pore-water pressure in the test specimen."

3.6.3 *calculation or calculated value, n*—the act or process of using an equation which converts a measured value(s) into another define quantity, without interpolation.

3.6.3.1 *Discussion*—Some examples being: converting diameter to area or diameter and height to volume, or mass, height, and diameter to density.

3.6.4 *determine or determined value, n*—the act or process of quantifying measured or calculated or both value(s) into another value(s) that requires judgment based on education, training, or experience.

3.6.4.1 *Discussion*—A simplified example is: "Determine the preconsolidation stress based on the test results from a consolidation test (either Test Method D2435/D2435M or D4186/D4186M)."

4. Summary of Practice

4.1 The user follows a set of guidelines that allow making decisions and actions that promote uniformity in the retention, rounding, and recording of significant digits for measured and calculated values involving geotechnical data.

4.2 The programmer and user make sure that the numbers are handled, interpreted, and reported accordingly for any specific requirements and caveats in the geotechnical standard for which the data were obtained.

5. Significance and Use

5.1 The guidelines presented in this practice for retaining significant digits and rounding numbers may be adopted by the using agency or user. Their adoption should generally be used to calculate and record data when specified requirements are not included in a standard.

5.2 While this practice originated when most geotechnical data were manually collected and recorded on data forms, tables, or into computers, the use of digital acquisition, calculations, and reporting of data has become more common. When calculators and computers are used for data collection, the significant digits may not meet the requirements specified in this standard. Nevertheless, their use shall not be regarded as nonconforming with this practice.