



# Standard Test Method for Laboratory Determination of Strength Properties of Frozen Soil at a Constant Rate of Strain<sup>1</sup>

This standard is issued under the fixed designation D7300; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

Knowledge of the stress-strain-strength behavior of frozen soil is of great importance for civil engineering construction in permafrost regions. The behavior of frozen soils under load is usually very different from that of unfrozen soils because of the presence of ice and unfrozen water films. In particular, frozen soils are much more subject to creep and relaxation effects, and their behavior is strongly affected by temperature change. In addition to creep, volumetric consolidation may also develop in frozen soils having large unfrozen water or gas contents.

As with unfrozen soil, the deformation and strength behavior of frozen soils depends on interparticle friction, particle interlocking, and cohesion. In frozen soil, however, bonding of particles by ice may be the dominant strength factor. The strength of ice in frozen soil is dependent on many factors, such as temperature, pressure, strain rate, grain size, crystal orientation, and density. At very high ice contents (ice-rich soils), frozen soil behavior under load is similar to that of ice. In fact, for fine-grained soils, experimental data suggest that the ice matrix dominates when mineral volume fraction is less than about 50 %. At low ice contents, however, (ice-poor soils), when interparticle forces begin to contribute to strength, the unfrozen water films play an important role, especially in fine-grained soils. Finally, for frozen sand, maximum strength is attained at full ice saturation and maximum dry density (1).<sup>2</sup>

## 1. Scope\*

1.1 This test method covers the determination of the strength behavior of cylindrical specimens of frozen soil, subjected to uniaxial compression under controlled rates of strain. It specifies the apparatus, instrumentation, and procedures for determining the stress-strain-time, or strength versus strain rate relationships for frozen soils under deviatoric creep conditions.

1.2 Values stated in SI units are to be regarded as the standard.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.19 on Frozen Soils and Rock.

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<sup>2</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.3.1 For the purposes of comparing measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal or significant digits in the specified limits.

1.3.2 The procedures used to specify how data are collected/recorded or calculated, in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, 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. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

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

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.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

**D653** Terminology Relating to Soil, Rock, and Contained Fluids

**D3740** Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

**D4083** Practice for Description of Frozen Soils (Visual-Manual Procedure)

**D6026** Practice for Using Significant Digits in Geotechnical Data

## 3. Terminology

### 3.1 Definitions:

3.1.1 For definitions of common technical terms in this standard, refer to Terminology **D653**.

3.1.2 Definitions of the components of freezing and thawing soils shall be in accordance with the terminology in Practice **D4083**.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 The following terms are used in conjunction with the determination of the strength properties of frozen soils and supplement those in Practice **D4083** and in the glossary on permafrost terms by Harris et al (2).

3.2.2 *creep of frozen ground*—the irrecoverable time-dependent deviatoric deformation that results from long-term application of a deviatoric stress.

3.2.3 *excess ice*—the volume of ice in the ground which exceeds the total pore volume that the ground would have under unfrozen conditions.

3.2.4 *failure*—the stress condition at failure for a test specimen. Failure is often taken to correspond to the maximum principal stress difference (maximum deviator stress) attained, or the principal stress difference (deviator stress) at 15 % axial strain, whichever is obtained first during the performance of a test. Depending on frozen soil behavior and field application, other suitable failure criteria may be defined, such as the principal stress difference (deviator stress) at a selected axial strain or strain rate.

3.2.5 *ground ice*—a general term referring to all types of ice formed in freezing or frozen ground.

3.2.6 *ice-bearing permafrost*—permafrost that contains ice.

3.2.7 *ice-bonded permafrost*—ice-bearing permafrost in which the soil particles are cemented together by ice.

3.2.8 *ice content*—the ratio of the mass of ice contained in the pore spaces of frozen soil or rock material, to the mass of solid particles in that material, expressed as percentage.

3.2.9 *ice lens*—a dominant horizontal, lens-shaped body of ice of any dimension.

3.2.10 *ice-rich permafrost*—permafrost containing excess ice.

3.2.11 *permafrost*—soil or rock that remains frozen (temperature < 0°C) for a period of two or more years.

3.2.12 *pore ice*—ice occurring in the pores of soil and rocks.

3.2.13 *sample*—piece or quantity of bulk material that has been selected by some sampling process.

3.2.14 *specimen*—pieces or quantity taken or prepared from a sample for testing.

3.2.15 *total water content*—the ratio of the mass of water (unfrozen water + ice) contained in the pore spaces of frozen soil or rock material, to the mass of solid particles in that material, expressed as percentage.

3.2.16 *unfrozen water content*—the ratio of the mass of water (free and adsorbed) contained in the pore spaces of frozen soil or rock material, to the mass of solid particles in that material, expressed as percentage (2).

## 4. Summary of Test Method

4.1 A cylindrical frozen soil specimen is cut to length and the ends are machined flat. The specimen is placed in a loading chamber and allowed to stabilize at a desired test temperature. A strain rate in compression is applied to the specimen and held constant at the specified temperature for the duration of the test. Axial stress and deformation of the specimen are monitored continuously. Typical results of a set of uniaxial compression tests are shown in Fig. X1.1 (3).

## 5. Significance and Use

5.1 Understanding the mechanical properties of frozen soils is of primary importance to frozen ground engineering. Data from strain rate controlled compression tests are necessary for the design of most foundation elements embedded in, or bearing on frozen ground. They make it possible to predict the time-dependent settlements of piles and shallow foundations under service loads, and to estimate their short and long-term bearing capacity. Such tests also provide quantitative parameters for the stability analysis of underground structures that are created for permanent or semi-permanent use.

5.2 It must be recognized that the structure of frozen soil in situ and its behavior under load may differ significantly from that of an artificially prepared specimen in the laboratory. This is mainly due to the fact that natural permafrost ground may contain ice in many different forms and sizes, in addition to the pore ice contained in a small laboratory specimen. These large ground-ice inclusions (such as ice lenses) will considerably affect the time-dependent behavior of full-scale engineering structures.

5.3 In order to obtain reliable results, high-quality intact representative permafrost samples are required for compression strength tests. The quality of the sample depends on the

<sup>3</sup> 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.

type of frozen soil sampled, the in situ thermal condition at the time of sampling, the sampling method, and the transportation and storage procedures prior to testing. The best testing program can be ruined by poor-quality samples. In addition, one must always keep in mind that the application of laboratory results to practical problems requires much caution and engineering judgment.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

## 6. Apparatus

6.1 *Axial Loading Device*—The axial compression device shall be capable of maintaining a constant strain rate within one percent of the applied strain rate. The device may be a screw jack driven by an electric motor through a geared transmission, a platform weighing scale equipped with a screw-jack-activated load yoke, a deadweight load apparatus, a hydraulic or pneumatic loading device, or any other compression device with sufficient capacity and control to provide the loading conditions prescribed in Section 8. Vibrations due to the operation of the loading device should be kept at a minimum.

6.2 *Axial Load-Measuring Device*—The axial load-measuring device may be a load ring, electronic load cell, hydraulic load cell, or any other load measuring device capable of the accuracy prescribed in this paragraph and may be a part of the axial loading device. For frozen soil with a deviator stress at failure of less than 100 kPa, the axial load measuring device shall be capable of measuring the unit axial load to an accuracy equivalent to 1 kPa; for frozen soil with a deviator stress at failure of 100 kPa and greater, the axial load-measuring device shall be capable of measuring the axial load to an accuracy of 1 % of the axial load at failure.

6.3 *Measurement of Axial Deformation*—The interaction between the test specimen and the testing machine loading system can affect the test results. For this reason, in order to observe the true stress-strain-rate behavior of a frozen soil specimen, deformations should be measured directly on the specimen. This can be achieved by mounting deformation gages on special holders attached to the sides of the specimen (4). If deformations are measured between the loading platens, it should be recognized that some initial deformation (seating error) will occur between the specimen ends and the loading surface of the platens.

6.4 *Bearing Surfaces*—The specimen cap and base shall be constructed of a noncorrosive impermeable material, and each shall have a circular plane surface of contact with the specimen and a circular cross section. The weight of the specimen cap shall be less than 0.5 % of the applied axial load at failure. The diameter of the cap and base shall be greater than the diameter of the specimen. The stiffness of the end cap should normally be high enough to distribute the applied load uniformly over the loading surface of the specimen. The specimen base shall be coupled to the compression chamber so as to prevent lateral

motion or tilting, and the specimen cap shall be designed to receive the piston, such that the piston-to-cap contact area is concentric with the cap.

NOTE 2—It is advisable not to use ball or spherical seats that would allow rotation of the platens, but rather special care should be taken in trimming or molding the ends of the specimen to parallel planes. The ends of the specimen shall be flat to 0.02 mm and shall not depart from perpendicularity to the axis of the specimen by more than 0.001 radian (about 3.5 min) or 0.05 mm in 50 mm. Effects of end friction on specimen deformation can be tolerated if the height to diameter ratio of the test specimen is two to three. However, it is recommended that lubricated platens be used whenever possible in the uniaxial compression and creep testing of frozen soils. The lubricated platen should consist of a circular sheet of 0.8-mm thick latex membrane, attached to the loading face of a steel platen with a 0.5-mm thick layer of high-vacuum silicone grease. The steel platens are polished stainless steel disks about 10 mm larger than the specimen diameter. As the latex sheets and grease layers compress under load, the axial strain of the specimen should be measured using extensometers located on the specimen (5, 6).

6.5 *Thermal Control*—The compressive strength of frozen soil is also affected greatly by temperature and its fluctuations. It is imperative, therefore, that specimens be stored and tested in a freezing chamber that has only a small temperature fluctuation to minimize thermal disturbance. Reduce the effect of fluctuations in temperature by enclosing the specimen in an insulating jacket during storage and testing. Reference (7) suggests the following permissible temperature variations when storing and testing frozen soils within the following different ranges:

Temperature, °C	0 to -2	-2 to -5	-5 to -10	below -10
Permissible deviation, °C	±0.1	±0.2	±0.5	±1.0

## 7. Test Specimen

### 7.1 *Thermal Disturbance Effects:*

7.1.1 The strength and deformation properties of frozen soil samples are known to be affected by sublimation, evaporation, and thermal disturbance. Their effect is in the redistribution and ultimate loss of moisture from the sample as the result of a temperature gradient or low-humidity environment, or both. Loss of moisture reduces the cohesion between soil particles and may reduce the strength (that is dependent on temperature). The effects of moisture redistribution in frozen soil are thought to change its strength and creep behavior.

7.1.2 Thermal disturbance of a frozen sample refers not only to thawing, but also to temperature fluctuations. Soil structure may be changed completely if the sample is thawed and then refrozen. Temperature fluctuations can set up thermal gradients, causing moisture redistribution and possible change in the unfrozen moisture content. Take care, therefore, to ensure that frozen soil specimens remain in their natural state, and that they are protected against the detrimental effects of sublimation and thermal disturbance until testing is completed.

7.1.3 In the event that the soil sample is not maintained at the in situ temperature prior to testing, bring the test specimen to the test temperature from a higher temperature to reduce the hysteresis effect on the unfrozen water content.

7.1.4 Before testing, maintain the test specimen at the test temperature for a sufficient period, to ensure that the temperature is uniform throughout the volume.

## 7.2 Machining and Preparation of Specimens for Testing (7):

7.2.1 The machining and preparation procedures used for frozen soils depend upon the size and shape of the specimen required, the type of soil, and the particular test being performed. Follow similar procedures for cutting and machining both naturally frozen and artificially frozen samples.

7.2.2 Handle frozen soil samples with gloves and all tools and equipment kept in the cold room to avoid sample damage by localized thawing. A temperature of  $-5 \pm 1^\circ\text{C}$  is the most suitable ambient temperature for machining with respect to material workability and personal comfort. At warmer temperatures, surface thawing is a problem, and cutting tools must be cleaned frequently, for they become coated and clogged with frozen soil, reducing their cutting efficiency. Working at colder temperatures is uncomfortable and slow. The soil is also difficult to work with because of increased hardness; cracks may also be formed easily in it, due to increased brittleness.

7.2.3 After being cut roughly to the required dimension, rectangular specimens are finished usually by one, or a combination, of the following methods, listed in increasing order of precision:

- (1) Hand shaving with a sharp, straight cutting edge (for example a draw knife).
- (2) A coarse wood rasp or file.
- (3) Grinding with several grades of emery paper or grinding stone.
- (4) Milling machine equipped with heavy-duty cutters.
- (5) Drill press (heavy duty) equipped with an end milling tool.

7.2.3.1 The particular application of each of the methods is dependent upon the required specimen tolerances.

7.2.3.2 Cylindrical specimens are either machined on a metal-working lathe or cut carefully with a coring tube in the laboratory. They can also be cored from block samples, using a diamond set core barrel and a large industrial drill press. For machining on a metal-working lathe, the best results are obtained when the specimen is turned at 690 r/min and the carriage feed set at 30 mm per 36 revolutions. Limit the maximum depth of cut to 0.38 mm. A tungsten carbide cutting tool, with a minimum back clearance of  $45^\circ$ , gives the best results. For clean cuts, sharpen the tool often, as the abrasive action of the soil dulls the edge quickly (8). Shaping coarse sand or gravel specimens on a lathe is difficult, because the soil grains are pulled out leaving an uneven pitted surface that should be made smooth by filling the pits with ice and fine sand mixture. It is important that the ends of the specimen are parallel and plane, so that intimate contact occurs with the loading platens.

### 7.3 Test Specimen Shape and Size:

7.3.1 Both the shape and size of frozen soil test specimens can influence the results of uniaxial compression tests. The sizes of specimens used in compression testing are generally a compromise between theoretical and practical considerations. Some of these considerations are:

7.3.1.1 The influence of boundary conditions of the test, that, among other things, include the lateral restraint imposed on the test specimen by the end platens,

7.3.1.2 The maximum size of particles in a soil specimen,

7.3.1.3 The loading capacity of the available loading equipment,

7.3.1.4 The maximum dimensions and weight of a test specimen that can be handled conveniently,

7.3.1.5 The size of soil samples that can be taken from a field site using common sampling methods, and

7.3.1.6 Equipment that is readily available to shape and protect specimens.

7.3.2 To reduce the influence of boundary conditions and that of maximum soil particle size, the test specimen should be as large as can be tested conveniently.

7.3.3 From the testing of unfrozen soils, the importance of the ratio of specimen height to diameter has long been recognized as an important factor where the type of loading platens influences the test results. Experience with compression testing of frozen soils (7, 9, 10) indicates that consistent creep and strength results can be obtained when the height to diameter ratio is 3:2, regardless of the type of end platens used in testing. Based on this information, it is recommended that: the shape of the test specimen be a right circular cylinder, the height-to-diameter ratio of the test specimen be two to three, the minimum diameter of the test specimen be at least ten times the maximum soil particle size, and either 50 or 100-mm diameter be used when the soil particle size does not control the diameter size.

## 8. Procedure

8.1 *Requirements for Placing Specimen in Test Apparatus*—Place the lower platen on the base of the loading device. Wipe clean the bearing faces of the upper and lower platens and of the test specimen, and place the specimen on the lower platen. Place the upper platen on the specimen and align properly. A small axial load, approximately 20 to 50 kPa, may be applied to the specimen by means of the loading device to properly seat the bearing parts of the apparatus.

8.2 *Temperature-Control Requirements*—When appropriate, install temperature-controlled enclosure and deformation transducers for the apparatus and sensors used. During the test, keep the temperature variations in the specimen within the limits of tolerance indicated in 6.5.

### 8.3 Test Procedure:

8.3.1 The strain rates at which compression tests are conducted depends upon the type of frozen soil (clay, silt, sand, or gravel), the temperature, and stresses it is expected to experience during the life of the structure.

8.3.2 To provide a common basis for comparing the results of compression tests, the following optional procedure is recommended:

8.3.2.1 First, determine the short-term uniaxial compression strength,  $q$ , of the frozen soil under investigation, by performing uniaxial compression tests with a constant axial strain rate of 1 %/min (0.017 %/s), related to the initial height of the specimen.



8.3.2.2 For subsequent compression tests, strain rates should be a fraction of the short-term uniaxial compression strength,  $q$ , of the soil under investigation.

8.3.2.3 Perform four or more compression tests, each with a different constant strain rate  $\dot{\bar{\epsilon}}_1$ , for example, 0.1, 0.01, and 0.001 times  $\dot{\bar{\epsilon}}_1$ , respectively.

#### 8.4 Recording:

8.4.1 At a minimum, record load and deformation values at increments of 0.1 to 1 % strain and, thereafter, at every 1 %. Take sufficient readings to define the stress-strain curve; hence, more frequent readings may be required in the early stages of the test and as failure is approached. Continue the loading to 15 % strain, except loading may be stopped when the principal stress difference (deviator stress) has dropped 20 %, or when 5 % additional axial strain occurs after a peak in principal stress difference (deviator stress).

8.4.2 Record the load and specimen temperature either continuously or each time the strain or deformation is read.

#### 8.5 Number of Tests:

8.5.1 For satisfying the requirements under 8.3.2.1 and 8.3.2.3, and taking into account a possible scatter of experimental results, a minimum of 15 specimens for each selected temperature and moisture content combination is needed for determination of uniaxial compression strength properties of a given frozen soil.

## 9. Calculation

9.1 Calculate the conventional axial strain,  $\epsilon_1$ , for a given applied axial load, as follows:

$$\epsilon_1 = \Delta L / L_o \quad (1)$$

where:

$\Delta L$  = change in length of specimen as read from deformation indicator, and

$L_o$  = initial length of test specimen when piston contacts specimen cap.

9.2 Calculate the average cross-sectional area,  $A$ , for a given applied compressive axial load as follows:

$$A = A_o / (1 - \epsilon_1) \quad (2)$$

where:

$A_o$  = initial average cross-sectional area of the specimen, and

$\epsilon_1$  = axial strain for the given axial load.

9.3 Calculate the deviator stress (principal stress difference), for a given applied axial load as follows:

$$(\sigma_1 - \sigma_3) = P/A \quad (3)$$

where:

$P$  = given applied axial load (corrected for uplift and piston friction, if required),

$A$  = corresponding average cross-sectional area, and

$\sigma_1, \sigma_3$  = principal normal stresses in axial and radial direction, respectively.

9.4 Calculate the *true axial strain rate*, defined as (9):

$$\dot{\bar{\epsilon}}_1 = (dL/L)/dt \quad (4)$$

where:

$L$  = current length of the specimen, and

$dL$  = increment (positive for decrease).

9.4.1 After a time  $t$ , the true strain  $\bar{\epsilon}_1$  is related to the conventional strain  $\epsilon_1 = \Delta L/L_o$  the expression:

$$\bar{\epsilon}_1 = -\ln(1 - \epsilon_1) \quad (5)$$

from which, for a given constant true strain rate,  $\dot{\bar{\epsilon}}_1 = \dot{\bar{\epsilon}}_{1c}$  one can deduce the required relationship between the movement of the platens and time,  $\Delta L = f(t)$  in the form:

$$\Delta L = L_o [1 - \exp(-\dot{\bar{\epsilon}}_{1c} t)] \quad (6)$$

## 10. Report

10.1 Report the following information:

10.1.1 *Description of Soil*—Unified Soil Classification system for frozen soils, grain size gradation curve, Atterberg limits (where applicable), physical properties, including total water content, dry unit weight of soil, specific gravity of soil grains, water/ice saturation in percent, and salinity.

10.1.2 *Sampling Conditions and Specimen Preparation*—Sampling method, ground temperature at the time of sampling, temperature fluctuation during transportation and storage, specimen machining method, and specimen dimensions.

10.1.3 *Testing Conditions*—Test temperature, end conditions of test specimen, loading conditions, including data on loading equipment, description of all tests, and graphs of test results as described in 9.4.

## 11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of the frozen soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program. In addition, it is either not feasible or too costly to produce multiple specimens that have uniform physical properties. Any variation observed in the data is just as likely to be due to specimen variation as to operator or laboratory testing variation.

11.1.1 Subcommittee D18.19 is seeking any data from users of this test method that might be used to make a limited statement on precision.

11.2 *Bias*—There is no accepted reference value for this test method, therefore bias cannot be determined.

## 12. Keywords

12.1 deformation; frozen soil; strength; strain; strain rate; stress; temperature; uniaxial compression

APPENDIXES

(Nonmandatory Information)

X1. GENERAL CONSIDERATIONS ON UNIAXIAL COMPRESSION TESTING OF FROZEN SOILS

X1.1 Constant Strain Rate Tests:

X1.1.1 It is well established that saturated frozen soil specimens tested in uniaxial compression at a constant rate of loading show an increase in resistance when the rate of loading is increased. This increased resistance has an upper limit which is influenced by both the soil type and test temperature (Fig. X1.2). At relatively low rates of applied loading, relatively warm test specimens deform plastically, with no clear fracture surface occurring even at strains as high as 20%. In fine-grained soils tested just below 0°C, there is often no distinct maximum or peak stress observed, even at these large strains. On the other hand, frozen coarse-grained soils such as sands, can exhibit either plastic or brittle type of failures, depending upon the specimen temperature and the rate of applied load. It would be highly desirable to choose for a standard an applied rate of strain that produces test specimen failures which are independent of the applied strain rate. However, such a rate would often be higher than the capabilities of the testing machines available to most engineering organizations. Also, for test specimens 100 mm long, uniformly applied rates of

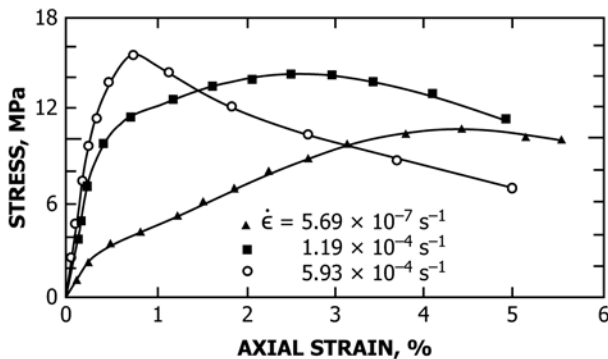


FIG. X1.1 Typical Stress-Strain Curves for a Frozen Sand at Different Strain Rates (T = -10°C) (3)

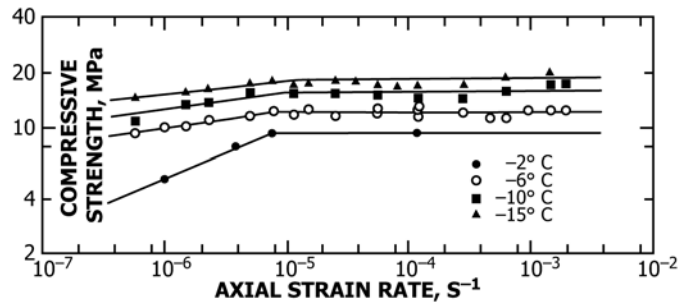


FIG. X1.2 Compressive Strength versus Strain Rate Relationship for a Frozen Sand at Different Temperatures (3)

strain lower than about 0.1 %/min (0.0017 %/s) are difficult to attain on most commonly used testing machines. Therefore, from a practical point of view, it appears that standard rates of applied strain must be arbitrary and higher than 0.1 %/min (5).

X1.2 Uniaxial Compression Creep Tests can provide parameters needed to estimate time-dependent deformation and strength of a frozen soil. The range of strain rates selected for creep tests depends on the frozen soil type (clay, silt, sand, or gravel) and the temperature and stresses expected during the life of the structure.

X1.3 Effect of Temperature and Salinity on Creep and Strength:

X1.3.1 Creep and strength properties of frozen soils are strongly influenced by their temperature, mainly because of the temperature-dependent behavior of the pore ice and the variation with temperature of the unfrozen water content.

X1.3.2 The effect of increasing salinity of pore water on creep and strength of a frozen soil is in many aspects similar to that of increasing temperature, because both of them affect the unfrozen water content that is a governing factor in the frozen soil behavior.

X2. STORAGE AND PROTECTION OF SAMPLES

X2.1 General—Protect intact block and core samples of frozen soil from thawing and loss of moisture, from the time they are taken from the ground and throughout the period of transportation, storage, machining, and testing. In most cases the sample must be maintained under the same thermal and moisture conditions existing at the time of sampling.

X2.2 In the Field and During Transportation—In the field, when the samples have been examined visually and logged at the site, wrap them in cellophane and place them in polyethylene bags. Evacuate air from the bag, and seal it to reduce sublimation. This can best be accomplished by using a vacuum pump, but can also be done by forcing most of the air out by

hand before sealing. Maintain humidity by placing some snow or crushed ice inside and around the outside of the bag. After the sample has been packaged, to keep sublimation to a minimum, some facility is required at the site to prevent thermal disturbance. When frozen samples are obtained for strength and creep tests, maintain their temperature as close as possible to the in situ temperature. As ground temperatures vary with depth during the year, determine the temperature at the time of sampling. If adequate storage facilities are not available at the field site, and the samples are to remain frozen, transport them immediately to a humidity- and temperature-controlled storage area, and ship them to the laboratory in refrigerated containers or insulated boxes (7).

X2.3 *Before and During Testing*—Careful control of temperature and humidity in storage areas is necessary to protect frozen specimens from sublimation and thermal disturbance, from the time they have been molded or machined, or both, until testing has been completed. Protection methods are

similar to those used when transporting frozen samples from the field. Wrap specimens in an impermeable material and store them in a refrigerated room or freezer. Minimize their sublimation by controlling the humidity and reducing air flow around the specimens.

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## SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this test method since the last issue, D7300–06, that may impact the use of this test method. (Approved November 1, 2011)

- (1) Added new **1.3** to reference Practice **D6026** and renumbered subsequent paragraphs.
- (2) Revised Section **3** to add reference to Terminology **D653** and Practice **D4083**. Inserted reference to Harris et al **(2)** in Definitions of Terms Specific to this Standard. Renumbered subsections accordingly. Deleted old 3.2.
- (3) Added new **Note 1** referencing Practice **D3740** in Section **5** Significance and Use and renumbered subsequent notes.
- (4) Changed “working lathe” to “metal-working lathe” in **7.2.3.2**.
- (5) Revised Section **11** Precision and Bias to conform to ASTM Form and Style.

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