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Standard Terminology Relating to Soil, Rock, and Contained Fluids[1]

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These definitions were prepared jointly by the American Society of Civil Engineers and the American Society for Testing and Materials.

INTRODUCTION

A number of the definitions include symbols and indicate the units of measurement. The symbols appear in italics immediately after the name of the term, followed by the unit in parentheses. No significance should be placed on the order in which the symbols are presented where two or more are given for an individual term. The applicable units are indicated by capital letters, as follows:

F—Force, such as pound-force, ton-force, newton

L—Length, such as inch, foot, centimetre

T—Time, such as second, minute

D—Dimensionless

Positive exponents designate multiples in the numerator. Negative exponents designate multiples in the denominator. Degrees of angle are indicated as "degrees."

Expressing the units either in SI or the inch-pound system has been purposely omitted in order to leave the choice of the system and specific unit to the engineer and the particular application, for example:

FL^{-2}—may be expressed in pounds-force per square inch, kilopascals, tons per square foot, etc.

LT^{-1}—may be expressed in feet per minute, centimetres per second, etc.

Where synonymous terms are cross-referenced, the definition is usually included with the earlier term alphabetically. Where this is not the case, the later term is the more significant.

Definitions marked with (ISRM) are taken directly from the publication in Ref 42 and are included for the convenience of the user.

For a list of ISRM symbols relating to soil and rock mechanics, refer to Appendix X1.

A list of references used in the preparation of these definitions appears at the end.

AASHTO compaction—see **compaction test**.

''A" Horizon—see **horizon**.

abandonment—see **decommissioning**. **D 5299**

abrasion—a rubbing and wearing away. (ISRM)

abrasion—the mechanical wearing, grinding, scraping or rubbing away (or down) of rock surfaces by friction or impact, or both.

abrasive—any rock, mineral, or other substance that, owing to its superior hardness, toughness, consistency, or other properties, is suitable for grinding, cutting, polishing, scouring, or similar use.

abrasiveness—the property of a material to remove matter when scratching and grinding another material. (ISRM)

absorbed water—water held mechanically in a soil or rock mass and having physical properties not substantially different from ordinary water at the same temperature and pressure.

absorption—the assimilation of fluids into interstices.

absorption loss—that part of transmitted energy (mechanical) lost due to dissipation or conversion into other forms (heat, etc.).

accelerator—a material that increases the rate at which chemical reactions would otherwise occur.

activator—a material that causes a catalyst to begin its function.

active earth pressure—see **earth pressure**.

active state of plastic equilibrium—see **plastic equilibrium**.

additive—any material other than the basic components of a grout system.

[1] This terminology is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.25 on Erosion and Sediment Control Technology.

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adhesion—shearing resistance between soil and another material under zero externally applied pressure.

	Symbol	Unit
Unit Adhesion	c_a	FL^{-2}
Total Adhesion	C_a	F or FL^{-1}

adhesion—shearing resistance between two unlike materials under zero externally applied pressure.

admixture—a material other than water, aggregates, or cementitious material, used as a grout ingredient for cement-based grouts.

adsorbed water—water in a soil or rock mass attracted to the particle surfaces by physiochemical forces, having properties that may differ from those of pore water at the same temperature and pressure due to altered molecular arrangement; adsorbed water does not include water that is chemically combined within the clay minerals.

adsorption—the attachment of water molecules or ions to the surfaces of soil particles.

advancing slope grouting—a method of grouting by which the front of a mass of grout is caused to move horizontally by use of a suitable grout injection sequence.

aeolian deposits—wind-deposited material such as dune sands and loess deposits.

aggregate—*as a grouting material*, relatively inert granular mineral material, such as sand, gravel, slag, crushed stone, etc. "Fine aggregate" is material that will pass a No. 4 (6.4-mm) screen,

"Coarse aggregate" is material that will not pass a No. 4 (6.4-mm) screen. Aggregate is mixed with a cementing agent (such as Portland cement and water) to form a grout material.

agitator tank—a tank, usually vertical and with open top, with rotation paddles used to prevent segregation of grout after mixing.

air entry value—the applied suction at which water menisci of the porous segment of a suction sampler break down, and air enters. **D 4696**

air-space ratio, G_a (D)—ratio of: (*1*) volume of water that can be drained from a saturated soil or rock under the action of force of gravity, to (*2*) total volume of voids.

air-void ratio, G_v (D)—the ratio of: (*1*) the volume of air space, to (*2*) the total volume of voids in a soil or rock mass.

alkali aggregate reaction—a chemical reaction between Na_2O and K_2O in the cement and certain silicate minerals in the cement and certain silicate minerals in the aggregate, which causes expansion resulting in weakening and cracking of Portland cement grout. See **reactive aggregate**.

allowable bearing value (allowable soil pressure), q_a, p_a (FL^{-2})—the maximum pressure that can be permitted on foundation soil, giving consideration to all pertinent factors, with adequate safety against rupture of the soil mass or movement of the foundation of such magnitude that the structure is impaired.

allowable pile bearing load, Q_a, P_a (F)—the maximum load that can be permitted on a pile with adequate safety against movement of such magnitude that the structure is endangered.

alluvium—soil, the constituents of which have been transported in suspension by flowing water and subsequently deposited by sedimentation.

amplification factor—ratio of dynamic to static displacement.

amorphous peat—see **sapric peat**.

angle of external friction (angle of wall friction), δ (degrees)—angle between the abscissa and the tangent of the curve representing the relationship of shearing resistance to normal stress acting between soil and surface of another material.

angle of friction (angle of friction between solid bodies), ϕ_s (degrees)—angle whose tangent is the ratio between the maximum value of shear stress that resists slippage between two solid bodies at rest with respect to each other, and the normal stress across the contact surfaces.

angle of internal friction (angle of shear resistance), ϕ (degrees)—angle between the axis of normal stress and the tangent to the Mohr envelope at a point representing a given failure-stress condition for solid material.

angle of obliquity, α, β, ϕ, Ψ (degrees)—the angle between the direction of the resultant stress or force acting on a given plane and the normal to that plane.

angle of repose, α (degrees)—angle between the horizontal and the maximum slope that a soil assumes through natural processes. For dry granular soils the effect of the height of slope is negligible; for cohesive soils the effect of height of slope is so great that the angle of repose is meaningless.

angle of shear resistance—see **angle of internal friction**.

angle of wall friction—see **angle of external friction**.

angular aggregate—aggregate, the particles of which possess well-defined edges formed at the intersection of roughly planar faces.

anisotropic mass—a mass having different properties in different directions at any given point.

anisotropy—having different properties in different directions. (ISRM)

annual space; annulus—the space between two concentric tubes or casings, or between the casing and the borehole wall. This would include the space(s) between multiple strings of tubing/casings in a borehole installed either concentrically or multi-cased adjacent to each other. **D 5092**

apparent cohesion—see **cohesion**.

aquiclude—a relatively impervious formation capable of absorbing water slowly but will not transmit it fast enough to furnish an appreciable supply for a well or spring.

aquifer—a geologic formation, group of formations, of part of a formation that is saturated and is capable of providing a significant quantity of water. **D 5092**

aquifer, confined—an aquifer bounded above and below by confining beds and in which the static head is above the top of the aquifer. **D 4050, D 4104, D 4105, D 4106, D 5269**

aquifer, unconfined—an aquifer that has a water table. **D 4043, D 4105, D 4106**

aquitard—a confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer; a leaky confining bed.

arching—the transfer of stress from a yielding part of a soil or

rock mass to adjoining less-yielding or restrained parts of the mass.

area grouting—grouting a shallow zone in a particular area utilizing holes arranged in a pattern or grid.

DISCUSSION—This type of grouting is sometimes referred to as blanket or consolidation grouting.

area of influence of a well, α (L^2)—area surrounding a well within which the piezometric surface has been lowered when pumping has produced the maximum steady rate of flow.

area ratio of a sampling spoon, sampler, or sampling tube, A_r (D)—the area ratio is an indication of the volume of soil displaced by the sampling spoon (tube), calculated as follows:

$$A_r = [(D_e^2 - D_i^2/D_i^2] \times 100 \quad (1)$$

where:

D_e = maximum external diameter of the sampling spoon, and

D_i = minimum internal diameter of the sampling spoon at the cutting edge.

armor—the artificial surfacing of bed, banks, shore, or embankment to resist erosion or scour.

armor stone—(generally one ton to three tons in weight) stone resulting from blasting, cutting, or by other methods to obtain rock heavy enough to require handling two individual pieces by mechanical means.

ash content—the percentage by dry weight of material remaining after an oven dry organic soil or peat is burned by a prescribed method.

assessment monitoring—an investigative monitoring program that is initiated after the presence of a contaminant in ground water has been detected. The objective of this program is to determine the concentration of constituents that have contaminated the ground water and to quantify the rate and extent of migration of these constituents. **D 5092**

ASTM cement types—Portland cements meeting the requirements of Specifications C 150. Cement types have slightly different formulations that result in various characteristics which address different construction conditions and different physical and chemical environments. They are as follows:

Type I (Portland)—a general-purpose construction cement with no special properties. **D 5092**

Type II (Portland)—a construction cement that is moderately resistant to sulfates and generates a lower head of hydration at a slower rate than Type I **D 5092**

Type III (Portland: high early strength)—a construction cement that produces a high early strength. This cement reduces the curing time required when used in cold environments, and produces a higher head of hydration than Type I. **D 5092**

Type IV (Portland)—a construction cement that produces a low head of hydration (lower than Types I and II) and develops strength at a slower rate. **D 5092**

Type V (Portland)—a construction cement that is a high sulfate resistant formulation. Used when there is severe sulfate action from soils and ground water.

attapulgite clay—a chain-lattice clay mineral. The term also applies to a group of clay materials that are lightweight, tough, matted, and fibrous.

attenuation—reduction of amplitude with time or distance.

''B" horizon—see **horizon**.

average interstitial velocity—see **velocity, average interstitial**.

backpack grouting—the filling with grout of the annular space between a permanent tunnel lining and the surrounding formation.

DISCUSSION—Same as crown grouting and backfill grouting.

back-packing—any material (usually granular) that is used to fill the empty space between the lagging and the rock surface. (ISRM)

baffle—a pier, weir, sill, fence, wall, or mound built on the bed of a stream to parry, deflect, check, or regulate the flow or to float on the surface to dampen the wave action.

bailer—a hollow tubular receptacle used to facilitate withdrawal of fluid from a well or borehole. **D 5092**

ballast—materials used to provide stability to a buoyant object (such as casing within a borehole filled with water). **D 5092**

barometric efficiency—the ratio of the change in depth to water in a well to the inverse of water-level change in barometric pressure, expressed in length of water. **D 4043**

base—*in grouting*, main component in a grout system.

base course (base)—a layer of specified or selected material of planned thickness constructed on the subgrade or subbase for the purpose of serving one or more functions such as distributing load, providing drainage, minimizing frost action, etc.

base exchange—the physicochemical process whereby one species of ions adsorbed on soil particles is replaced by another species.

batch—*in grouting*, quantity of grout mixed at one time.

batch method—*in grouting*, a quantity of grout materials are mixed or catalyzed at one time prior to injection.

batch mixer—*in grouting*, a machine that mixes batches of grout, in contrast to a continuous mixer.

bearing capacity—see **ultimate bearing capacity**.

bearing capacity (of a pile), Q_p, P_p (F)—the load per pile required to produce a condition of failure.

bedding—applies to rocks resulting from consolidation of sediments and exhibiting surfaces of separation (bedding planes) between layers of the same or different materials, that is, shale, siltstone, sandstone, limestone, etc. (ISRM)

bedding—collective term signifying the existence of layers of beds. Planes or other surfaces dividing sedimentary rocks of the same or different lithology.

bedrock—the more or less continuous body of rock which underlies the overburden soils. (ISRM)

bedrock (ledge)—rock of relatively great thickness and extent in its native location.

bench—(*1*) the unexcavated rock having a nearly horizontal surface which remains after a top heading has been excavated, or (*2*) step in a slope; formed by a horizontal surface and a surface inclined at a steeper angle than that of the entire slope. (ISRM)

bending—process of deformation normal to the axis of an elongated structural member when a moment is applied

normal to its long axis. (ISRM)

bentonitic clay—a clay with a high content of the mineral montmorillonite, usually characterized by high swelling on wetting.

berm—a shelf that breaks the continuity of a slope.

biaxial compression—compression caused by the application of normal stresses in two perpendicular directions. (ISRM)

biaxial state of stress—state of stress in which one of the three principal stresses is zero. (ISRM)

binder (soil binder)—portion of soil passing No. 40 (425-µm) U.S. standard sieve,

binder—anything that causes cohesion in loosely assembled substances, such as clay or cement.

bit—any device that may be attached to or is an integral part of a drill string and is used as a cutting tool to bore into or penetrate rock or other materials.

blaine fineness—the fineness of powdered materials, such as cement and pozzolans, expressed as surface area usually in square centimetres per gram.

blanket grouting—a method in which relatively closely spaced shallow holes are drilled and grouted on a grid pattern over an area, for the purpose of making the upper portions of the bedrock stronger and less pervious.

blastibility—index value of the resistance of a rock formation to blasting. (ISRM)

blasting cap (detonator, initiator)—a small tube containing a flashing mixture for firing explosives. (ISRM)

bleeding—*in grouting*, the autogeneous flow of mixing water within, or its emergence from, newly placed grout caused by the settlement of the solid materials within the mass.

bleeding rate—*in grouting*, the rate at which water is released from grout by bleeding.

blocking—wood blocks placed between the excavated surface of a tunnel or shaft and the main bracing system. (ISRM)

blow-in—the inflow of ground water and unconsolidated material into a borehole or casing caused by differential hydraulic heads; that is, caused by the presence of a greater hydraulic head outside of a borehole/casing than inside. **D 5092**

blowout—a sudden or violent uncontrolled escape of fluids or gas, or both, from a borehole. **D 5299**

body force—a force such as gravity whose effect is distributed throughout a material body by direct action on each elementary part of the body independent of the others. (ISRM)

bog—a peat covered area with a high water table and a surface dominated by a carpet of mosses, chiefly sphagnum. It is generally nutrient poor and acidic. It may be treed or treeless.

bond strength—*in grouting*, resistance to separation of set grout from other materials with which it is in contact; a collective expression for all forces such as adhesion, friction, and longitudinal shear.

borehole—a hole of circular cross-section made in soil or rock.

DISCUSSION—normally, a borehole is advanced using an auger, a drill, or casing with or without drilling fluid. **D 4750**

borehole log—the record of geologic units penetrated, drilling progress, depth, water level, sample recovery, volumes and types of materials used, and other significant facts regarding the drilling of an exploratory borehole or well. **D 5092**

borehole television log—a borehole or well video record produced by lowering a television camera into the borehole or well. This record is useful in visually observing downhole conditions such as collapsed casing or a blocked screen.

bottom charge—concentrated explosive charge at the bottom of a blast hole. (ISRM)

boulder clay—a geological term used to designate glacial drift that has not been subjected to the sorting action of water and therefore contains particles from boulders to clay sizes.

boulders—a rock fragment, usually rounded by weathering or abrasion, with an average dimension of 12 in. (305 mm) or more.

breakwater stone—(generally three tons to twenty tons in weight) stone resulting from blasting, cutting, or other means to obtain rock heavy enough to require handling individual pieces by mechanical means.

bridge—an obstruction within the annulus which may prevent circulation or proper emplacement of annular materials. **D 5092**

bubbling pressure—the applied air pressure at which water menisci of the porous segment of a suction sampler break down, and air exists. **D 4696**

buckling—a bulge, bend, bow, kink, or wavy condition produced in sheets, plates, columns, or beams by compressive stresses.

bulb of pressure—see **pressure bulb**.

bulk density, ρ —the mass of a quantity of a bulk solid divided by its total volume.

bulk solid —an assembly of solid particles handled in sufficient quantities that its characteristics can be described by the properties of the mass of particles rather than the characteristics of each individual particle. May also be referred to as granular material, particulate solid or powder. Examples are sugar, flour, ore, and coal.

bulkhead—a steep or vertical structure supporting natural or artificial embankment.

bulking—the increase in volume of a material due to manipulation. Rock bulks upon being excavated; damp sand bulks if loosely deposited, as by dumping, because the apparent cohesion prevents movement of the soil particles to form a reduced volume.

bunker — synonym for **bin**, but sometimes understood as being a bin without any or only a samll vertical part at the top of the hopper.

buoyant unit weight (*submerged unit weight*)—see **unit weight**.

burden—*in an explosive blasting,* the distance between the charge and the free face of the material to be blasted.

burden—distance between charge and free surface in direction of throw. (ISRM)

''C" Horizon—see **horizon**.

California bearing ratio, *CBR* (D)—the ratio of: (*1*) the force per unit area required to penetrate a soil mass with a 3-in.^{2}(19-cm)^2 circular piston (approximately 2-in. (51-mm) diameter) at the rate of 0.05 in. (1.3 mm)/min, to (*2*) that

required for corresponding penetration of a standard material. The ratio is usually determined at 0.1-in. (2.5-mm) penetration, although other penetrations are sometimes used. Original California procedures required determination of the ratio at 0.1-in. intervals to 0.5 in. (12.7 mm). Corps of Engineers' procedures require determination of the ratio at 0.1 in. and 0.2 in. (5.1 mm). Where the ratio at 0.2 in. is consistently higher than at 0.1 in., the ratio at 0.2 in. is used.

caliper log—a geophysical borehole log that shows to scale the variations with depth in the mean diameter of a cased or uncased borehole. **D 5299**

camouflet—the underground cavity created by a fully contained explosive. (ISRM)

capillary action (capillarity)—the rise or movement of water in the interstices of a soil or rock due to capillary forces.

capillary flow—see **capillary action**.

capillary fringe—the basal region of the vadose zone comprising sediments that are saturated, or nearly saturated, near the water table, gradually decreasing in water content with increasing elevation above the water table. **D 5314**

capillary fringe zone—the zone above the free water elevation in which water is held by capillary action.

capillary head, h (L)—the potential, expressed in head of water, that causes the water to flow by capillary action.

capillary migration—see **capillary action**.

capillary rise (height of capillary rise), h_c (L)—the height above a free water elevation to which water will rise by capillary action.

capillary water—water subject to the influence of capillary action.

cascading water—perched ground water that enters a well casing via cracks or uncovered perforations, trickling, or pouring down the inside of the casing. **D 5696, D 4700**

casing—pipe, finished in sections with either threaded connections or bevelled edges to be field welded which is installed temporarily or permanently to counteract caving, to advance the borehole, or to isolate the zone being monitored, or combination thereof. **D 5092**

casing, protective—a section of larger diameter pipe that is emplaced over the upper end of a smaller diameter monitoring well riser or casing to provide structural protection to the well and restrict unauthorized access into the well. **D 5092**

casing, surface—pipe used to stabilize a borehole near the surface during the drilling of a borehole that may be left in place or removed once drilling is completed. **D 5092**

catalyst—a material that causes chemical reactions to begin.

catalyst system—those materials that, in combination, cause chemical reactions to begin; catalyst systems normally consist of an initiator (catalyst) and an activator.

cation—an ion that moves, or would move toward a cathode; thus nearly always synonymous with positive ion.

cation exchange—see **base exchange**.

cation exchange capacity (CEC)—the total capacity of a porous system to absorb cations from a solution. **D 4696**

caving; sloughing—the inflow of unconsolidated material into a borehole which occurs when the borehole walls lose their cohesive strength. **D 5092**

cavity—a natural underground opening that may be small or large.

cavity—underground opening created by a fully contained explosive. (ISRM)

cement, API, Class A—a cement intended for use from the surface to a depth of 6000 ft (1828 m). This cement is similar to ASTM Type I cement. **D 5299**

cement, API, Class B—a cement intended for use from the surface to a depth of 6000 ft (1828 m) when conditions require moderate- to high-sulfate resistance. This cement is similar to ASTM Type II cement. **D 529**

cement, API, Class C—this cement is intended for use from the surface to a depth of 6000 ft (1828 m) when conditions require high early strength. This cement is similar to ASTM Type III cement. Also available as a high sulfate resistant type. **D 5299**

cement, API, Class G—this cement is intended for use from the surface to a depth of 8000 ft (2438 m). It can be used with accelerators or retarders to cover a wide range of well depths and temperatures. No additions other than calcium sulfate or water, or both, can be intergound or blended with the clinker during manufacture of the cement. Also available as several sulfate-resistant types. **D 5299**

cement, API, Class H—this cement is intended for use from the surface to a depth of 8000 ft (2438 m). It can be used with accelerators or retarders to cover a wide range of well depths and temperatures. No additions other than calcium sulfate or water, or both, can be interground or blended with the clinker during manufacture of the cement. Also available as a sulfate-resistant type. **D 5299**

cement, API, Class J—this cement is intended for use from depths of 12 000 to 16 000 ft (3658 to 4877 m) under conditions of extremely high temperatures and pressures. It can be used with accelerators and retarders to cover a range of well depths and temperatures. No additions of retarders other than calcium sulfate, or water, or both, can be interground or blended with the clinker during manufacture of the cement. **D 5299**

cement bond (sonic) log—a borehole geophysical log that can be used to determine the effectiveness of a cement seal of the annular space of a well. **D 5299**

cement factor—quantity of cement contained in a unit volume of concrete or grout, expressed as weight, or volume (specify which).

cement grout—a grout in which the primary cementing agent is Portland cement.

cement; Portland cement—commonly known as Portland cement. A mixture that consists of a calcareous argillaceous, or other silica-, alumina,- and iron-oxide bearing materials that is manufactured and formulated to produce various types which are defined in Specification C 150. Portland cement is also considered a hydraulic cement because it must be mixed with water to form a cement-water paste that has the ability to harden and develop strength even if cured under water (see **ASTM cement types**). **D 5092**

cementitious factor—quantity of cement and other cementitious materials contained in a unit volume of concrete or grout, expressed as weight or volume (specify which).

centralizer—a device that assists in the centering of a casing or riser within a borehole or another casing. **D 5092**

centrifuge moisture equivalent—see **moisture equivalent**.

chamber—a large room excavated underground, for example, for a powerhouse, pump station, or for storage. (ISRM)

chamber blasting (coyotehole blasting)—a method of quarry blasting in which large explosive charges are confined in small tunnel chambers inside the quarry face. (ISRM)

channeling—the process of forming a vertical cavity resulting from a faulty cement job in the annular space. **D 5299**

chemical grout—any grouting material characterized by being a true solution; no particles in suspension. See also **particulate grout**.

chemical grout system—any mixture of materials used for grouting purposes in which all elements of the system are true solutions (no particles in suspension).

chip—crushed angular rock fragment of a size smaller than a few centimetres. (ISRM)

chisel—the steel cutting tool used in percussion drilling. (ISRM)

circuit grouting—a grouting method by which grout is circulated through a pipe extending to the bottom of the hole and back up the hole via the annular space outside the pipe. Then the excess grout is diverted back over a screen to the agitator tank by means of a packing gland at the top of the hole. The method is used where holes tend to cave and sloughing material might otherwise clog openings to be grouted.

circulation—applies to the fluid rotary drilling method; drilling fluid movement from the mud pit, through the pump, hose and swivel, drill pipe, annular space in the hole and returning to the mud pit. **D 5092**

ciromg accelerator—a material added to cement to decrease the time for curing. Examples are sodium chloride, calcium sulfate (gypsum), and aluminum powder. **D 5299**

clay (clay soil)—fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. The term has been used to designate the percentage finer than 0.002 mm (0.005 mm in some cases), but it is strongly recommended that this usage be discontinued, since there is ample evidence from an engineering standpoint that the properties described in the above definition are many times more important.

clay size—that portion of the soil finer than 0.002 mm (0.005 mm in some cases) (see also **clay**).

clay soil—see **clay**.

cleavage—*in crystallography*, the splitting, or tendency to split, along planes determined by the crystal structure. *In petrology*, a tendency to cleave or split along definite, parallel, closely spaced planes. It is a secondary structure, commonly confined to bedded rocks.

cleavage—the tendency to cleave or split along definite parallel planes, which may be highly inclined to the bedding. It is a secondary structure and is ordinarily accompanied by at least some recrystallization of the rock. (ISRM)

cleavage planes—the parallel surfaces along which a rock or mineral cleaves or separates; the planes of least cohesion, usually parallel to a certain face of the mineral or crystal.

cleft water—water that exists in or circulates along the geological discontinuities in a rock mass.

closure—the opening is reduced in dimension to the extent that it cannot be used for its intended purpose. (ISRM)

closure—*in grouting*, closure refers to achieving the desired reduction in grout take by splitting the hole spacing. If closure is being achieved, there will be a progressive decrease in grout take as primary, secondary, tertiary, and quanternary holes are grouted.

cobble (cobblestone)—a rock fragment, usually rounded or semirounded, with an average dimension between 3 and 12 in. (75 and 305 mm).

coefficient of absolute viscosity—see **coefficient of viscosity**.

coefficient of active earth pressure—see **coefficient of earth pressure**.

coefficient of compressibility (coefficient of compression), α_v (L^2F^{-1})—the secant slope, for a given pressure increment, of the pressure-void ratio curve. Where a stress-strain curve is used, the slope of this curve is equal to $\alpha_v/(1 + e)$.

coefficient of consolidation, c_v (L^2T^{-1})—a coefficient utilized in the theory of consolidation, containing the physical constants of a soil affecting its rate of volume change.

$$c_v = k\,(1 + e)/\alpha_v\gamma_w \qquad (2)$$

where:

k = coefficient of permeability, LT^{-1},
e = void ratio, D,
α_v = coefficient of compressibility, L^2F^{-1}, and
γ_w = unit weight of water, FL^{-3}.

DISCUSSION—In the literature published prior to 1935, the coefficient of consolidation, usually designated c, was defined by the equation:

$$c = k/\alpha_v\gamma_w\,(1 + e) \qquad (3)$$

This original definition of the coefficient of consolidation may be found in some more recent papers and care should be taken to avoid confusion.

coefficient of earth pressure, K (D)—the principal stress ratio at a point in a soil mass.

coefficient of earth pressure, active, K_A (D)—the minimum ratio of : (*1*) the minor principal stress, to (*2*) the major principal stress. This is applicable where the soil has yielded sufficiently to develop a lower limiting value of the minor principal stress.

coefficient of earth pressure, at rest, K_O (D)—the ratio of: (*1*) the minor principal stress, to (*2*) the major principal stress. This is applicable where the soil mass is in its natural state without having been permitted to yield or without having been compressed.

coefficient of earth pressure, passive, K_P (D)—the maximum ratio of: (*1*) the major principal stress, to (*2*) the minor principal stress. This is applicable where the soil has been compressed sufficiently to develop an upper limiting value of the major principal stress.

coefficient of friction (coefficient of friction between solid bodies), f (D)—the ratio between the maximum value of shear stress that resists slippage between two solid bodies with respect to each other, and the normal stress across the contact surfaces. The tangent of the angle of friction is ϕs.

coefficient of friction, f—a constant proportionality factor,

μ, relating normal stress and the corresponding critical shear stress at which sliding starts between two surfaces: $T = \mu\sigma$. (ISRM)

coefficient of internal friction, μ (D)—the tangent of the angle of internal friction (angle of shear resistance) (see **internal friction**).

coefficient of permeability (permeability), k (LT^{-1})—the rate of discharge of water under laminar flow conditions through a unit cross-sectional area of a porous medium under a unit hydraulic gradient and standard temperature conditions (usually 20°C).

coefficient of shear resistance—see **coefficient of internal friction,** μ (D).

coefficient of subgrade reaction (modulus of subgrade reaction), k, k_s (FL^{-3})—ratio of: (*1*) load per unit area of horizontal surface of a mass of soil, to (*2*) corresponding settlement of the surface. It is determined as the slope of the secant, drawn between the point corresponding to zero settlement and the point of 0.05-in. (1.3-mm) settlement, of a load-settlement curve obtained from a plate load test on a soil using a 30-in. (762-mm) or greater diameter loading plate. It is used in the design of concrete pavements by the Westergaard method.

coefficient of transmissibility—the rate of flow of water in gallons per day through a vertical strip of the aquifer 1 ft (0.3 m) wide, under a unit hydraulic gradient.

coefficient of uniformity, C_u (D)—the ratio D_{60}/D_{10}, where D_{60} is the particle diameter corresponding to 60 % finer on the cumulative particle-size distribution curve, and D_{10} is the particle diameter corresponding to 10 % finer on the cumulative particle-size distribution curve.

coefficient of viscosity (coefficient of absolute viscosity), η (FTL^{-2})—the shearing force per unit area required to maintain a unit difference in velocity between two parallel layers of a fluid a unit distance apart.

coefficient of volume compressibility (modulus of volume change), m_v (L^2F^{-1})—the compression of a soil layer per unit of original thickness due to a given unit increase in pressure. It is numerically equal to the coefficient of compressibility divided by one plus the original void ratio, or $a_v/(1 + e)$.

cohesion—shear resistance at zero normal stress (an equivalent term in rock mechanics is intrinsic shear strength). (ISRM)

cohesion, c (FL^{-2})—the portion of the shear strength of a soil indicated by the term c, in Coulomb's equation, $s = c + p \tan \phi$. See **intrinsic shear strength**.

apparent cohesion—cohesion in granular soils due to capillary forces.

cohesionless soil—a soil that when unconfined has little or no strength when air-dried and that has little or no cohesion when submerged.

cohesive soil—a soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

collar—*in grouting*, the surface opening of a borehole.

colloidal grout—*in grouting*, a grout in which the dispersed solid particles remain in suspension (colloids).

colloidal mixer—*in grouting*, a mixer designed to produce colloidal grout.

colloidal particles—particles that are so small that the surface activity has an appreciable influence on the properties of the aggregate.

communication—*in grouting*, subsurface movement of grout from an injection hole to another hole or opening.

compaction—the densification of a soil by means of mechanical manipulation.

compaction curve (Proctor curve) (moisture-density curve)—the curve showing the relationship between the dry unit weight (density) and the water content of a soil for a given compactive effort.

compaction test (moisture-density test)—a laboratory compacting procedure whereby a soil at a known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit weight determined. The procedure is repeated for various water contents sufficient to establish a relation between water content and unit weight.

compressibility—property of a soil or rock pertaining to its susceptibility to decrease in volume when subjected to load.

compression curve—see **pressure-void ratio curve**.

compression index, C_c (D)—the slope of the linear portion of the pressure-void ratio curve on a semi-log plot.

compression wave (irrotational)—wave in which element of medium changes volume without rotation.

compressive strength (unconfined or uniaxial compressive strength), p_c, q_u, C_o (FL^{-2})—the load per unit area at which an unconfined cylindrical specimen of soil or rock will fail in a simple compression test. Commonly the failure load is the maximum that the specimen can withstand in the test.

compressive stress—normal stress tending to shorten the body in the direction in which it acts. (ISRM)

concentration factor, n (D)—a parameter used in modifying the Boussinesq equations to describe various distributions of vertical stress.

conceptual model—a simplified representation of the hydrogeologic setting and the response of the flow system to stress. **D 4043**

conductance (specific)—a measure of the ability of the water to conduct an electric current at 77°F (25°C). It is related to the total concentration of ionizable solids in the water. It is inversely proportional to electrical resistance. **D 5092**

cone of impression, *n*—a rise of the potentiometric surface in the approximate shape of a cone that develops around an injection well.

confining bed—a hydrogeologic unit of less permeable material bounding one or more aquifers. **D 4043, D 4050, D 4104, D 4105, D 4106, D 5269**

confining unit—a term that is synonymous with "aquiclude," "aquitard," and "aquifuge": defined as a body of relatively low permeable material stratigraphically adjacent to one or more aquifers. **D 5092**

conjugate joints (faults)—two sets of joints (faults) that formed under the same stress conditions (usually shear pairs). (ISRM)

connate water, *n*—water entrapped in the voids of a sedimentary or extrusive igneous rock at the time of its deposition or emplacement.

consistency—the relative ease with which a soil can be deformed.

consistency—*in grouting*, the relative mobility or ability of freshly mixed mortar or grout to flow; the usual measurements are slump for stiff mixtures and flow for more fluid grouts.

consistency index—see **relative consistency**.

consolidated-drained test (slow test)—a soil test in which essentially complete consolidation under the confining pressure is followed by additional axial (or shearing) stress applied in such a manner that even a fully saturated soil of low permeability can adapt itself completely (fully consolidate) to the changes in stress due to the additional axial (or shearing) stress.

consolidated-undrained test (consolidated quick test)—a soil test in which essentially complete consolidation under the vertical load (in a direct shear test) or under the confining pressure (in a triaxial test) is followed by a shear at constant water content.

consolidation—the gradual reduction in volume of a soil mass resulting from an increase in compressive stress

initial consolidation (*initial compression*)—a comparatively sudden reduction in volume of a soil mass under an applied load due principally to expulsion and compression of gas in the soil voids preceding primary consolidation.

primary consolidation (*primary compression*) (*primary time effect*)—the reduction in volume of a soil mass caused by the application of a sustained load to the mass and due principally to a squeezing out of water from the void spaces of the mass and accompanied by a transfer of the load from the soil water to the soil solids.

secondary consolidation (*secondary compression*) (*secondary time effect*)—the reduction in volume of a soil mass caused by the application of a sustained load to the mass and due principally to the adjustment of the internal structure of the soil mass after most of the load has been transferred from the soil water to the soil solids.

consolidation curve—see **consolidation time curve.**

consolidation grouting—injection of a fluid grout, usually sand and Portland cement, into a compressible soil mass in order to displace it and form a lenticular grout structure for support.

DISCUSSION—In rock, grouting is performed for the purpose of strengthening the rock mass by filling open fractures and thus eliminating a source of settlement.

consolidation ratio, U_s (D)—the ratio of: (*1*) the amount of consolidation at a given distance from a drainage surface and at a given time, to (*2*) the total amount of consolidation obtainable at that point under a given stress increment.

consolidation test—a test in which the specimen is laterally confined in a ring and is compressed between porous plates.

consolidation-time curve (time curve) (consolidation curve) (theoretical time curve)—a curve that shows the relation between: (*1*) the degree of consolidation, and (*2*) the elapsed time after the application of a given increment of load.

constant-head boundary—the conceptual representation of a natural feature such as a lake or river that effectively fully penetrates the aquifer and prevents water-level change in the aquifer at that location. **D 5270**

constitutive equation—force deformation function for a particular material. (ISRM)

contact grouting—see **backpack grouting**.

contact pressure, p (FL^{-2})—the unit of pressure that acts at the surface of contact between a structure and the underlying soil or rock mass.

contaminant—an undesirable substance not normally present in water or soil. **D 5092**

continuous mixer—a mixer into which the ingredients of the mixture are fed without stopping, and from which the mixed product is discharged in a continuous stream.

contraction—linear strain associated with a decrease in length. (ISRM)

control rinse water—water used for equipment washing and rinsing having a known chemistry. **D 5088**

control well—well by which the aquifer is stressed, for example, by pumping, injection, or change of head. **D 4043, D 4044, D 4104, D 4105, D 5269**

controlled blasting—includes all forms of blasting designed to preserve the integrity of the remaining rocks, that is, smooth blasting or pre-splitting. (ISRM)

controlled-strain test—a test in which the load is so applied that a controlled rate of strain results.

controlled-stress test—a test in which the stress to which a specimen is subjected is applied at a controlled rate.

convergence—generally refers to a shortening of the distance between the floor and roof of an opening, for example, in the bedded sedimentary rocks of the coal measures where the roof sags and the floor heaves. Can also apply to the convergence of the walls toward each other. (ISRM)

core—a cylindrical sample of hardened grout, concrete, rock, or grouted deposits, usually obtained by means of a core drill.

core drilling; diamond drilling—a rotary drilling technique, using diamonds in the cutting bit, that cuts out cylindrical rock samples. (ISRM)

core recovery—ratio of the length of core recovered to the length of hole drilled, usually expressed as a percentage.

cover—the perpendicular distance from any point in the roof of an underground opening to the ground surface. (ISRM)

cover—*in grouting*, the thickness of rock and soil material overlying the stage of the hole being grouted.

crack—a small fracture, that is, small with respect to the scale of the feature in which it occurs. (ISRM)

crater—excavation (generally of conical shape) generated by an explosive charge. (ISRM)

creep—slow movement of rock debris or soil usually imperceptible except to observations of long duration. Time-dependent strain or deformation, for example, continuing strain with sustained stress.

critical circle (critical surface)—the sliding surface assumed in a theoretical analysis of a soil mass for which the factor of safety is a minimum.

critical damping—the minimum viscous damping that will

allow a displaced system to return to its initial position without oscillation.

critical density—the unit weight of a saturated granular material below which it will lose strength and above which it will gain strength when subjected to rapid deformation. The critical density of a given material is dependent on many factors.

critical frequency, f_c—frequency at which maximum or minimum amplitudes of excited waves occur.

critical height, H_c (L)—the maximum height at which a vertical or sloped bank of soil or rock will stand unsupported under a given set of conditions.

critical hydraulic gradient—see **hydraulic gradient**.

critical slope—the maximum angle with the horizontal at which a sloped bank of soil or rock of given height will stand unsupported.

critical surface—see **critical circle**.

critical void ratio—see **void ratio**.

crown—also roof or back, that is, the highest point of the cross section. *In tunnel linings*, the term is used to designate either the arched roof above spring lines or all of the lining except the floor or invert. (ISRM)

cryology—the study of the properties of snow, ice, and frozen ground.

cure—*in grouting*, the change in properties of a grout with time.

cure time—*in grouting*, the interval between combining all grout ingredients or the formation of a gel and substantial development of its potential properties.

curing retarder—a material added to cement to increase the time for curing. Sodium chloride in high concentrations is an example. **D 5299**

curtain grouting—injection of grout into a sub-surface formation in such a way as to create a barrier of grouted material transverse to the direction of the anticipated water flow.

cuttings—small-sized rock fragments produced by a rock drill. (ISRM)

d-10—the diameter of a soil particle (preferably in millimetres) at which 10 % by weight (dry) of the particles of a particular sample are finer. Synonymous with the effective size or effective grain size. **D 5092**

d-60—the diameter of a soil particle (preferably in millimetres) at which 60 % by weight (dry) of the particles of a particular sample are finer. **D 5092**

damping—reduction in the amplitude of vibration of a body or system due to dissipation of energy internally or by radiation. (ISRM)

damping ratio—for a system with viscous damping, the ratio of actual damping coefficient to the critical damping coefficient.

decay time—the interval of time required for a pulse to decay from its maximum value to some specified fraction of that value. (ISRM)

decommissioning (closure)—the engineered closure of a well, borehole, or other subsurface monitoring device sealed with plugging materials. Decommissioning also includes the planning and documenting of all associated activities. A synonym is abandonment. **D 5299**

decomposition—for peats and organic soils, see **humification**.

decontamination—the process of removing undesirable physical or chemical constituents, or both, from equipment to reduce the potential for cross-contamination. **D 5299**

The process of removing or reducing to a known level undesirable physical or chemical constituents, or both, from a sampling apparatus to maximize the representativeness of physical or chemical analysis proposed for a given sample. **D 5088**

decoupling—the ratio of the radius of the blasthole to the radius of the charge. In general, a reducing of the strain wave amplitude by increasing the spacing between charge and blasthole wall. (ISRM)

deflocculating agent (deflocculant) (dispersing agent)—an agent that prevents fine soil particles in suspension from coalescing to form flocs.

deformability—*in grouting*, a measure of the elasticity of the grout to distort in the interstitial spaces as the sediments move.

deformation—change in shape or size.

deformation—a change in the shape or size of a solid body. (ISRM)

deformation resolution (deformation sensitivity), R_d (L)—ratio of the smallest subdivision of the indicating scale of a deformation-measuring device to the sensitivity of the device.

degree-days—the difference between the average temperature each day and 32°F (0°C). In common usage degree-days are positive for daily average temperatures above 32°F and negative for those below 32°F (see **freezing index**).

degree of consolidation (percent consolidation), U (D)—the ratio, expressed as a percentage, of: (*1*) the amount of consolidation at a given time within a soil mass, to (*2*) the total amount of consolidation obtainable under a given stress condition.

degrees-of-freedom—the minimum number of independent coordinates required in a mechanical system to define completely the positions of all parts of the system at any instant of time. In general, it is equal to the number of independent displacements that are possible.

degree of saturation—see **percent saturation**.

degree of saturation—the extent or degree to which the voids in rock contain fluid (water, gas, or oil). Usually expressed in percent related to total void or pore space. (ISRM)

degree of sensitivity (*sensitivity ratio*)—see **remolding index**.

delay—time interval (fraction of a second) between detonation of explosive charges. (ISRM)

density—the mass per unit, ρ (ML^{-3}) kg/m^3.

density of dry soil or rock, ρ_d (ML^{-3}) kg/m^3—the mass of solid particles per the total volume of soil or rock.

density of saturated soil or rock, ρ_{sat} (ML^{-3}) kg/m^3—the total mass per total volume of completely saturated soil or rock.

density of soil or rock (*bulk density*), ρ (ML^{-3}) kg/m^3—the total mass (solids plus water) per total volume.

density of solid particles, ρ_s(ML^{-3}) kg/m^3—the mass per volume of solid particles.

density of submerged soil or rock, ρ_{sub} (ML^{-3}) kg/m^3—the

difference between the density of saturated soil or rock, and the density of water.

density of water, $\rho_w(ML^{-3})$ kg/m^3—the mass per volume of water.

detection monitoring—a program of monitoring for the express purpose of determining whether or not there has been a contaminant release to ground water. **D 5092**

detonation—an extremely rapid and violent chemical reaction causing the production of a large volume of gas. (ISRM)

deviator stress, Δ, σ (FL^{-2})—the difference between the major and minor principal stresses in a triaxial test.

deviator of stress (strain)—the stress (strain) tensor obtained by subtracting the mean of the normal stress (strain) components of a stress (strain) tensor from each normal stress (strain) component. (ISRM)

differential settlement—settlement that varies in rate or amount, or both, from place to place across a structure.

dilatancy—property of volume increase under loading. (ISRM)

dilatancy—the expansion of cohesionless soils when subject to shearing deformation.

direct shear test—a shear test in which soil or rock under an applied normal load is stressed to failure by moving one section of the sample or sample container (shear box) relative to the other section.

discharge velocity, v, q (LT^{-1})—rate of discharge of water through a porous medium per unit of total area perpendicular to the direction of flow.

discontinuity surface—any surface across which some property of a rock mass is discontinuous. This includes fracture surfaces, weakness planes, and bedding planes, but the term should not be restricted only to mechanical continuity. (ISRM)

dispersing agent—*in grouting*, an addition or admixture that promotes dispersion of particulate grout ingredients by reduction of interparticle attraction.

dispersing agent—see **deflocculating agent**.

dispersion—the phenomenon of varying speed of transmission of waves, depending on their frequency. (ISRM)

displacement—a change in position of a material point. (ISRM)

displacement grouting—injection of grout into a formation in such a manner as to move the formation; it may be controlled or uncontrolled. See also **penetration grouting**.

distortion—a change in shape of a solid body. (ISRM)

divergence loss—that part of transmitted energy lost due to spreading of wave rays in accordance with the geometry of the system.

double amplitude—total or peak to peak excursion.

drag bit—a noncoring or full-hole boring bit, which scrapes its way through relatively soft strata. (ISRM)

drain—a means for intercepting, conveying, and removing water.

drainage curtain—*in grouting*, a row of open holes drilled parallel to and downstream from the grout curtain of a dam for the purpose of reducing uplift pressures.

DISCUSSION—Depth is ordinarily approximately one-third to one-half that of the grout curtain.

drainage gallery—*in grouting*, an opening or passageway from which grout holes or drainage curtain holes, or both, are drilled. See also **grout gallery**.

drawdown (L)—vertical distance the free water elevation is lowered or the pressure head is reduced due to the removal of free water. **D 653**

drill—a machine or piece of equipment designed to penetrate earth or rock formations, or both.

drill cuttings—fragments or particles of soil or rock, with or without free water, created by the drilling process.

drilling fluid—a fluid (liquid or gas) that may be used in drilling operations in remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling. **D 5092**

drillability—index value of the resistance of a rock to drilling. (ISRM)

drill carriage; jumbo—a movable platform, stage, or frame that incorporates several rock drills and usually travels on the tunnel track; used for heavy drilling work in large tunnels. (ISRM)

drilling pattern—the number, position, depth, and angle of the blastholes forming the complete round in the face of a tunnel or sinking pit. (ISRM)

drill mud—*in grouting*, a dense fluid or slurry used in rotary drilling; to prevent caving of the bore hole walls, as a circulation medium to carry cuttings away from the bit and out of the hole, and to seal fractures or permeable formations, or both, preventing loss of circulation fluid.

DISCUSSION—The most common drill mud is a water-bentonite mixture, however, many other materials may be added or substituted to increase density or decrease viscosity.

dry pack—a cement-sand mix with minimal water content used to fill small openings or repair imperfections in concrete.

dry unit weight (*dry density*)—see **unit weight**.

ductility—condition in which material can sustain permanent deformation without losing its ability to resist load. (ISRM)

dye tracer—*in grouting*, an additive whose primary purpose is to change the color of the grout or water.

earth—see **soil**.

earth material—soil, bedrock, or fill. **D 4750**

earth pressure—the pressure or force exerted by soil on any boundary.

	Symbol	Unit
Pressure	p	FL^{-2}
Force	P	F or FL^{-1}

active earth pressure, P_A, p_A—the minimum value of earth pressure. This condition exists when a soil mass is permitted to yield sufficiently to cause its internal shearing resistance along a potential failure surface to be completely mobilized.

earth pressure at rest, P_o, p_o—the value of the earth pressure when the soil mass is in its natural state without having been permitted to yield or without having been compressed.

passive earth pressure, P_p, p_p—the maximum value of earth pressure. This condition exists when a soil mass is compressed sufficiently to cause its internal shearing resistance along a potential failure surface to be completely mobilized.

effect diameter (effective size), D_{10}, D_e (L)—particle diameter

corresponding to 10 % finer on the grain-size curve.

effective drainage porosity—see **effective porosity**.

effective force, $\bar{F}$ (F)—the force transmitted through a soil or rock mass by intergranular pressures.

effective porosity (effective drainage porosity), n_e (D)—the ratio of: (*1*) the volume of the voids of a soil or rock mass that can be drained by gravity, to (*2*) the total volume of the mass.

effective pressure—see **stress**.

effective size—see **effective diameter**.

effective stress—see **stress**.

effective unit weight—see **unit weight**.

efflux time—time required for all grout to flow from a flow cone.

elasticity—property of material that returns to its original form or condition after the applied force is removed. (ISRM)

elastic limit—point on stress strain curve at which transition from elastic to inelastic behavior takes place. (ISRM)

elastic state of equilibrium—state of stress within a soil mass when the internal resistance of the mass is not fully mobilized.

elastic strain energy—potential energy stored in a strained solid and equal to the work done in deforming the solid from its unstrained state less any energy dissipated by inelastic deformation. (ISRM)

electric log—a record or log of a borehole obtained by lowering electrodes into the hole and measuring any of the various electrical properties of the rock formations or materials traversed.

electrokinetics—involves the application of an electric field to soil for the purpose of dewatering materials of very low permeability to enhance stability. The electric field produces negative pore pressures near a grout pipe that facilitates grout injection.

elevator—synonym for **bin**, commonly used in the grain industry.

emplacement—the establishment of contaminant residence in the vadose zone in a particular phase. **D 5314**

emulsifier—a substance that modifies the surface tension of colloidal droplets, keeping them from coalescing, and keeping them suspended.

emulsion—a system containing dispersed colloidal droplets.

endothermic—pertaining to a reaction that occurs with the adsorption of heat.

envelope grouting—grouting of rock surrounding a hydraulic pressure tunnel for purpose of consolidation, and primarily, reduction of permeability.

epoxy—a multicomponent resin grout that usually provides very high, tensile, compressive, and bond strengths.

equipotential line—a line connecting points of equal hydraulic head. A set of such lines provides a contour map of a potentiometric surface. **D 5270**

equivalent diameter (equivalent size), D (L)—the diameter of a hypothetical sphere composed of material having the same specific gravity as that of the actual soil particle and of such size that it will settle in a given liquid at the same terminal velocity as the actual soil particle.

equivalent fluid—a hypothetical fluid having a unit weight such that it will produce a pressure against a lateral support presumed to be equivalent to that produced by the actual soil. This simplified approach is valid only when deformation conditions are such that the pressure increases linearly with depth and the wall friction is neglected.

excess hydrostatic pressure—see **hydrostatic pressure**.

exchange capacity—the capacity to exchange ions as measured by the quantity of exchangeable ions in a soil or rock.

excitation (stimulus)—an external force (or other input) applied to a system that causes the system to respond in some way.

exothermic—pertaining to a reaction that occurs with the evolution of heat.

expansive cement—a cement that tends to increase in volume after it is mixed with water.

extender—an additive whose primary purpose is to increase total grout volume.

extension—linear strain associated with an increase in length. (ISRM)

external force—a force that acts across external surface elements of a material body. (ISRM)

extrados—the exterior curved surface of an arch, as opposed to intrados, which is the interior curved surface of an arch. (ISRM)

fabric—*for rock or soil*, the spatial configuration of all textural and structural features as manifested by every recognizable material unit from crystal lattices to large scale features requiring field studies.

fabric—the orientation in space of the elements composing the rock substance. (ISRM)

face (heading)—the advanced end of a tunnel, drift, or excavation at which work is progressing. (ISRM)

facing—the outer layer of revetment.

failure (in rocks)—exceeding the maximum strength of the rock or exceeding the stress or strain requirement of a specific design. (ISRM)

failure (of a bulk solid)—plastic deformation of an overconsolidated bulk solid subject to shear, causing dilation and a decrease in strength.

failure by rupture—see **shear failure**.

failure criterion—specification of the mechanical condition under which solid materials fail by fracturing or by deforming beyond some specified limit. This specification may be in terms of the stresses, strains, rate-of-change of stresses, rate-of-change of strains, or some combination of these quantities, in the materials.

failure criterion—theoretically or empirically derived stress or strain relationship characterizing the occurrence of failure in the rock. (ISRM)

fallback—shrinkage, settlement, or loss of plugging material placed in a borehole or well. **D 5299**

false set—*in grouting*, the rapid development of rigidity in a freshly mixed grout without the evolution of much heat.

DISCUSSION—Such rigidity can be dispelled and plasticity regained by further mixing without the addition of water; premature stiffening, hesitation set, early stiffening, and rubber set are other much used terms referring to the same phenomenon.

fatigue—the process of progressive localized permanent structural change occurring in a material subjected to conditions that produce fluctuating stresses and strains at some point or points and that may culminate in cracks or complete fracture after a sufficient number of fluctuations.

fatigue—decrease of strength by repetitive loading. (ISRM)

fatigue limit—point on stress-strain curve below which no fatigue can be obtained regardless of number of loading cycles. (ISRM)

fault—a fracture or fracture zone along which there has been displacement of the two sides relative to one another parallel to the fracture (this displacement may be a few centimetres or many kilometres). (See also **joint fault set** and **joint fault system**. (ISRM)

fault breccia—the assemblage of broken rock fragments frequently found along faults. The fragments may vary in size from inches to feet. (ISRM)

fault gouge—a clay-like material occurring between the walls of a fault as a result of the movement along the fault surfaces. (ISRM)

fiber—*for peats and organic soils*, a fragment or piece of plant tissue that retains a recognizable cellular structure and is large enough to be retained after wet sieving on a 100-mesh sieve (openings 0.15 mm).

fibric peat—peat in which the original plant fibers are slightly decomposed (greater than 67 % fibers).

fibrous peat—see **fibric peat**.

field moisture equivalent—see **moisture equivalent**.

fill—man-made deposits of natural soils or rock products and waste materials.

filling—generally, the material occupying the space between joint surfaces, faults, and other rock discontinuities. The filling material may be clay, gouge, various natural cementing agents, or alteration products of the adjacent rock. (ISRM)

filter bedding stone—(generally 6-in. minus material) stone placed under graded riprap stone or armor stone in a layer or combination of layers designed and installed in such a manner as to prevent the loss of underlying soil or finer bedding materials due to moving water.

filter (protective filter)—a layer or combination of layers of pervious materials designed and installed in such a manner as to provide drainage, yet prevent the movement of soil particles due to flowing water.

final set—*in grouting*, a degree of stiffening of a grout mixture greater than initial set, generally stated as an empirical value indicating the time in hours and minutes that is required for cement paste to stiffen sufficiently to resist the penetration of a weighted test needle.

fineness—a measure of particle-size.

fineness modulus—an empirical factor obtained by adding the total percentages of an aggregate sample retained on each of a specified series of sieves, and dividing the sum by 100; in the United States, the U.S. Standard sieve sizes are: No. 100 (149 µm), No. 50 (297 µm), No. 30 (590 µm), No. 16 (1,190 µm), No. 8 (2,380 µm), and No. 4 (4,760 µm) and⅜ in. (9.5 mm), ¾ in. (19 mm), 1½ in. (38 mm), 3 in. (76 mm), and 6 in. (150 mm).

fines—portion of a soil finer than a No. 200 (75-µm) U.S. standard sieve.

finite element—one of the regular geometrical shapes into which a figure is subdivided for the purpose of numerical stress analysis. (ISRM)

fire clay—a silicious clay rich in hydrous aluminum silicates. **D 5299**

fishing tool—*in grouting*, a device used to retrieve drilling equipment lost or dropped in the hole.

fissure—a gapped fracture. (ISRM)

flash set—*in grouting*, the rapid development of rigidity in a freshly mixed grout, usually with the evolution of considerable heat; this rigidity cannot be dispelled nor can the plasticity be regained by further mixing without addition of water; also referred to as quick set or grab set.

floc—loose, open-structured mass formed in a suspension by the aggregation of minute particles.

flocculation—the process of forming flocs.

flocculent structure—see **soil structure**.

floor—bottom of near horizontal surface of an excavation, approximately parallel and opposite to the roof. (ISRM)

flow channel—the portion of a flow net bounded by two adjacent flow lines.

flow cone—*in grouting*, a device for measurement of grout consistency in which a predetermined volume of grout is permitted to escape through a precisely sized orifice, the time of efflux (flow factor) being used as the indication of consistency.

flow curve—the locus of points obtained from a standard liquid limit test and plotted on a graph representing water content as ordinate on an arithmetic scale and the number of blows as abscissa on a logarithmic scale.

flow function, FF—the plot of unconfined yield strength versus major consolidation stress for one specified bulk solid.

flow failure—failure in which a soil mass moves over relatively long distances in a fluid-like manner.

flow index, F_w, I_f (D)—the slope of the flow curve obtained from a liquid limit test, expressed as the difference in water contents at 10 blows and at 100 blows.

flow line—the path that a particle of water follows in its course of seepage under laminar flow conditions.

flow log—a borehole geophysical log used to record vertical movement of ground water and movement of water into or out of a well or borehole and between formations within a well. **D 5299**

flow net—a graphical representation of flow lines and equipotential (piezometric) lines used in the study of seepage phenomena.

flow path—represents the area between two flow lines along which ground water can flow. **D 5092**

flow slide—the failure of a sloped bank of soil in which the movement of the soil mass does not take place along a well-defined surface of sliding.

flow steady, *n*—a characteristic of a flow system where the specific discharge is constant in time at any point.

flow value, N_ϕ (degrees)—a quantity equal to tan [45 deg + (ϕ/2)].

flow velocity—see **specific discharge**.

fluidifier—*in grouting*, an admixture employed in grout to increase flowability without changing water content.

flush joint or flush coupled—casing or riser with ends threaded such that a consistent inside and outside diameter is maintained across the threaded joints or couplings. **D 5092**

fly ash—the finely divided residue resulting from the combustion of ground or powdered coal and which is transported from the firebox through the boiler by flue gases.

fold—a bend in the strata or other planar structure within the rock mass. (ISRM)

foliation—the somewhat laminated structure resulting from segregation of different minerals into layers parallel to the schistosity. (ISRM)

footing—portion of the foundation of a structure that transmits loads directly to the soil.

footwall—the mass of rock beneath a discontinuity surface. (ISRM)

forced vibration (forced oscillation)—vibration that occurs if the response is imposed by the excitation. If the excitation is periodic and continuing, the oscillation is steady-state.

forepoling—driving forepoles (pointed boards or steel rods) ahead of the excavation, usually over the last set erected, to furnish temporary overhead protection while installing the next set. (ISRM)

foundation—lower part of a structure that transmits the load to the soil or rock.

foundation soil—upper part of the earth mass carrying the load of the structure.

fracture—the general term for any mechanical discontinuity in the rock; it therefore is the collective term for joints, faults, cracks, etc. (ISRM)

fracture—a break in the mechanical continuity of a body of rock caused by stress exceeding the strength of the rock. Includes joints and faults.

fracture frequency—the number of natural discontinuities in a rock or soil mass per unit length, measured along a core or as exposed in a planar section such as the wall of a tunnel.

fracture pattern—spatial arrangement of a group of fracture surfaces. (ISRM)

fracturing—*in grouting*, intrusion of grout fingers, sheets, and lenses along joints, planes of weakness, or between the strata of a formation at sufficient pressure to cause the strata to move away from the grout.

fragmentation—the breaking of rock in such a way that the bulk of the material is of a convenient size for handling. (ISRM)

free product—liquid phase contaminants released into the environment. **D 5314**

free vapor phase—a condition of contaminant residence in which volatilized contaminants occur in porosity that is effective to free and open gaseous flow and exchange, such porosity generally being macroporosity. **D 5314**

free water (gravitational water) (ground water) (phreatic water)—water that is free to move through a soil or rock mass under the influence of gravity.

free water elevation (water table) (ground water surface) (free water surface) (ground water elevation)—elevations at which the pressure in the water is zero with respect to the atmospheric pressure.

freezing index, F (degree-days)—the number of degree-days between the highest and lowest points on the cumulative degree-days—time curve for one freezing season. It is used as a measure of the combined duration and magnitude of below-freezing temperature occurring during any given freezing season. The index determined for air temperatures at 4.5 ft (1.4 m) above the ground is commonly designated as the air freezing index, while that determined for temperatures immediately below a surface is known as the surface freezing index.

free vibration—vibration that occurs in the absence of forced vibration.

frequency, f (T^{-1})—number of cycles occurring in unit time.

frost action—freezing and thawing of moisture in materials and the resultant effects on these materials and on structures of which they are a part or with which they are in contact.

frost boil—(*a*) softening of soil occurring during a thawing period due to the liberation of water form ice lenses or layers.

(*b*) the hole formed in flexible pavements by the extrusion of soft soil and melt waters under the action of wheel loads.

(*c*) breaking of a highway or airfield pavement under traffic and the ejection of subgrade soil in a soft and soupy condition caused by the melting of ice lenses formed by frost action.

frost heave—the raising of a surface due to the accumulation of ice in the underlying soil or rock.

fundamental frequency—lowest frequency of periodic variation.

gage length, L (L)—distance over which the deformation measurement is made.

gage protector—*in grouting*, a device used to transfer grout pressure to a gage without the grout coming in actual contact with the gage.

gage saver—see **gage protector**.

gel—*in grouting*, the condition where a liquid grout begins to exhibit measurable shear strength.

gel time—*in grouting*, the measured time interval between the mixing of a grout system and the formation of a gel.

general shear failure—see **shear failure**.

geophysical borehole log—a log obtained by lowering an instrument into a borehole and continuously recording a physical property of native or backfill material and contained fluids. Examples include resistivity, induction, caliper, sonic, and natural gamma logs. **D 5299**

glacial till (till)—material deposited by glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

gradation (grain-size distribution) (texture)—the proportions by mass of a soil or fragmented rock distributed in specified particle-size ranges.

grain-size analysis (mechanical analysis) (particle-size analysis)—the process of determining grain-size distribution.

granular material—synonym for **bulk solid**.

gravel—rounded or semirounded particles of rock that will

pass a 3-in. (76.2-mm) and be retained on a No. 4 (4.75-µm) U.S. standard sieve.

gravel pack—common nomenclature for the terminology, primary filter of a well (see *primary filter pack*). **D 5092**

gravitational water—see **free water**.

gravity grouting—grouting under no applied pressure other than the height of fluid in the hole.

groin—bank or shore-protection structure in the form of a barrier placed oblique to the primary motion of water, designed to control movement of bed load.

ground arch—the theoretical stable rock arch that develops some distance back from the surface of the opening and supports the opening. (ISRM)

ground water—that part of the subsurface water that is in the saturated zone.

DISCUSSION—Loosely, all subsurface water as distinct from surface water.

ground-water barrier—soil, rock, or artificial material which has a relatively low permeability and which occurs below the land surface where it impedes the movement of ground water and consequently causes a pronounced difference in the potentiometric level on opposite sides of the barrier.

ground-water basin—a ground-water system that has defined boundaries and may include more than one aquifer of permeable materials, which are capable of furnishing a significant water supply.

DISCUSSION—A basin is normally considered to include the surface area and the permeable materials beneath it. The surface-water divide need not coincide with ground-water divide.

ground-water discharge—the water released from the zone of saturation; also the volume of water released.

ground-water divide—a ridge in the water table or other potentiometric surface from which ground water moves away in both directions normal to the ridge line.

ground-water elevation—see **free water elevation**.

ground-water flow—the movement of water in the zone of saturation.

ground-water level—the level or the water table surrounding a borehole or well. The ground-water level can be represented as an elevation or as a depth below the ground surface. **D 4750**

ground-water, perched—see **perched ground-water**.

ground-water recharge—the process of water addition to the saturated zone; also the volume of water added by this process.

ground-water surface—see **free water elevation.**

grout—*in soil and rock grouting*, a material injected into a soil or rock formation to change the physical characteristics of the formation.

grout (monitoring wells)—a low permeability material placed in the annulus between the well casing or riser pipe and the borehole wall (that is, in a single-cased monitoring well), or between the riser and casing (that is, in a multicased monitoring well), to maintain the alignment of the casing and riser and to prevent movement of ground water or surface water within the annular space. **D 5092**

groutability—the ability of a formation to accept grout.

groutability ratio of granular formations—the ratio of the 15 % size of the formation particles to be grouted to the 85 % size of grout particles (suspension-type grout). This ratio should be greater than 24 if the grout is to successfully penetrate the formation.

groutable rock bolts—rock bolts with hollow cores or with tubes adapted to the periphery of the bolts and extending to the bottom of the bolts to facilitate filling the holes surrounding the bolts with grout.

grouted-aggregate concrete—concrete that is formed by injecting grout into previously placed coarse aggregate. See also **preplaced aggregate concrete**.

grout cap—a "cap" that is formed by placing concrete along the top of a grout curtain. A grout cap is often used in weak foundation rock to secure grout nipples, control leakage, and to form an impermeable barrier at the top of a grout curtain.

grout gallery—an opening or passageway within a dam utilized for grouting or drainage operations, or both.

grout header—a pipe assembly attached to a ground hole, and to which the grout lines are attached for injecting grout. Grout injector is monitored and controlled by means of valves and a pressure gate mounted on the header; sometimes called grout manifold.

grout mix—the proportions or amounts of the various materials used in the grout, expressed by weight or volume. (The words "by volume" or "by weight" should be used to specify the mix.)

grout nipple—*in grouting*, a short length of pipe, installed at the collar of the grout hole, through which drilling is done and to which the grout header is attached for the purpose of injecting grout.

grout pipe—a pipe or tube that is used to transport cement, bentonite, or other plugging materials from the ground surface to a specified depth in a well or borehole. The material may be allowed to flow freely or it may be injected under pressure. The term tremie pipe is frequently used interchangeably. **D 5299**

grout slope—the natural slope of grout injected into preplaced-aggregate or other porous mass.

grout shoe—a plug fabricated of relatively inert materials that is positioned with the lowermost section of a permanent casing and fitted with a passageway, often with a flow check device, through which grout is injected under pressure to fill the annular space. After the grout has set, the grout shoe is usually drilled out. **D 5092**

grout system—formulation of different materials used to form a grout.

grout take—the measured quantity of grout injected into a unit volume of formation, or a unit length of grout hole.

hanging wall—the mass of rock above a discontinuity surface. (ISRM)

hardener—*in grouting*, in a two component epoxy or resin, the chemical component that causes the base component to cure.

hardness—resistance of a material to indentation or scratching. (ISRM)

hardpan—a hard impervious layer, composed chiefly of clay, cemented by relatively insoluble materials, that does not

become plastic when mixed with water and definitely limits the downward movement of water and roots.

head—pressure at a point in a liquid, expressed in terms of the vertical distance of the point below the surface of the liquid. (ISRM)

head (total)—the sum of three components at a point: (1) elevation head, *h* which is equal to the elevation of the point above a datum; (2) pressure head, *hp*, which is the height of a column of static water than can be supported by the static pressure at the point; and (3) velocity head, hv, which is the height the kinetic energy of the liquid is capable of lifting the liquid. **D 5092**

head, static—the height above a standard datus of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point. The static head is the sum of the elevation head and the pressure head. **D 5092**

heat of hydration—heat evolved by chemical reactions with water, such as that evolved during the setting and hardening of Portland cement.

heave—upward movement of soil caused by expansion or displacement resulting from phenomena such as: moisture absorption, removal of overburden, driving of piles, frost action, and loading of an adjacent area.

height of capillary rise—see **capillary rise**.

hemic peat—peat in which the original plant fibers are moderately decomposed (between 33 and 67 % fibers).

heterogeneity—having different properties at different points. (ISRM)

homogeneity—having different properties at different points. (ISRM)

homogeneity—having the same properties at all points. (ISRM)

homogeneous mass—a mass that exhibits essentially the same physical properties at every point throughout the mass.

honeycomb structure—see **soil structure**.

hopper—the converging portion of a bin.

horizon (soil horizon)—one of the layers of the soil profile, distinguished principally by its texture, color, structure, and chemical content.

"A" horizon—the uppermost layer of a soil profile from which inorganic colloids and other soluble materials have been leached. Usually contains remnants of organic life.

"B" horizon—the layer of a soil profile in which material leached from the overlying ''A" horizon is accumulated.

"C" horizon—undisturbed parent material from which the overlying soil profile has been developed.

humic peat—see **sapric peat**.

humification—a process by which organic matter decomposes.

DISCUSSION—The degree of humification for peats is indicated by the state of the fibers. In slightly decomposed material, most of the volume consists of fibers. In moderately decomposed material, the fibers may be preserved but may break down with disturbance, such as rubbing between the fingers. In highly decomposed materials, fibers will be virtually absent; see **von Post humification scale**.

humus—a brown or black material formed by the partial decomposition of vegetable or animal matter; the organic portion of soil.

hydration—formation of a compound by the combining of water with some other substance.

hydraulic communication—the migration of fluids from one zone to another, with reference to this guide, especially along a casing grout plug, or through back fill materials. **D 5299**

hydraulic conductivity (field aquifer tests)—the volume of water at the existing kinematic viscosity that will move in a unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. **D 4043, D 4044, D 4050, D 4104, D 4105, D 4106, D 5269**

hydraulic fracturing—the fracturing of an underground strata by pumping water or grout under a pressure in excess of the tensile strength and confining pressure; also called hydrofracturing.

hydraulic gradient—the change in total hydraulic head of water per unit distance of flow. **D 4696**

critical hydraulic gradient, i_c (D)—hydraulic gradient at which the intergranular pressure in a mass of cohesionless soil is reduced to zero by the upward flow of water.

hydrologic unit—geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units. Boundaries of a hydrologic unit may not necessarily correspond either laterally or vertically to lithostratigraphic formations. **D 5092**

hydrophobicity—the property that defines a material as being water repellent. Water exhibits an obtuse contact angle with hydrophobic materials. **D 4696**

Hydrophelicity—the property that defines a material as attracting water. Water exhibits an acute contact angle with hydrophilic materials. **D 4696**

hydrostatic head—the fluid pressure of formation water produced by the height of water above a given point.

hydrostatic pressure, u_o (FL^{-2})—a state of stress in which all the principal stresses are equal (and there is no shear stress), as in a liquid at rest; the product of the unit weight of the liquid and the different in elevation between the given point and the free water elevation.

excess hydrostatic pressure (*hydrostatic excess pressure*), $\bar{u}$, u (FL^{-2})—the pressure that exists in pore water in excess of the hydrostatic pressure.

hydrostatic pressure—a state of stress in which all the principal stresses are equal (and there is no shear stress). (ISRM)

hygroscopic capacity (hygroscopic coefficient), w_e (D)—ratio of: (*1*) the weight of water absorbed by a dry soil or rock in a saturated atmosphere at a given temperature, to (*2*) the weight of the oven-dried soil or rock.

hygroscopic water content, w_H (D)—the water content of an air-dried soil or rock.

hysteresis—incomplete recovery of strain during unloading cycle due to energy consumption. (ISRM)

image well—an imaginary well located opposite a control well such that a boundary is the perpendicular bisector of a straight line connecting the control and image wells; used to simulate the effect of a boundary on water-level changes. **D 5270**

impedance, acoustic—the product of the density and sonic velocity of a material. The extent of wave energy transmission and reflection at the boundary of two media is determined by their acoustic impedances. (ISRM)

impermable boundary—the conceptual representation of a natural feature such as a fault or depositional contact that places a boundary of significantly less-permeable material laterally adjacent to an aquifer. **D 5270**

inelastic deformation—the portion of deformation under stress that is not annulled by removal of stress. (ISRM)

inert—not participating in any fashion in chemical reactions.

influence value, *I* (D)—the value of the portion of a mathematical expression that contains combinations of the independent variables arranged in dimensionless form.

influent stream, *n*—see preferred term **losing stream**.

inhibitor—a material that stops or slows a chemical reaction from occurring.

initial consolidation (*initial compression*)—see **consolidation**.

initial set—a degree of stiffening of a grout mixture generally stated as an empirical value indicating the time in hours and minutes that is required for a mixture to stiffen sufficiently to resist the penetration of a weighted test needle.

injectability—see **groutability**.

inorganic silt—see **silt**.

in situ—applied to a rock or soil when occurring in the situation in which it is naturally formed or deposited.

intergranular pressure—see **stress**.

intermediate principal plane—see **principal plane**.

intermediate principal stress—see **stress**.

internal friction (shear resistance), (FL^{-2})—the portion of the shearing strength of a soil or rock indicated by the terms $p \tan \phi$ in Coulomb's equation $s = c + p \tan \phi$. It is usually considered to be due to the interlocking of the soil or rock grains and the resistance to sliding between the grains.

interstice—see preferred term **void**.

interstitial—occurring between the grains or in the pores in rock or soil.

intrinsic shear strength, S_o (FL^{-2})—the shear strength of a rock indicated by Coulomb's equation when $p \tan \phi$ (shear resistance or internal friction) vanishes. Corresponds to cohesion, *c*, in soil mechanics.

invert—on the cross section, the lowest point of the underground excavation or the lowest section of the lining. (ISRM)

isochrome—a curve showing the distribution of the excess hydrostatic pressure at a given time during a process of consolidation.

isotropic mass—a mass having the same property (or properties) in all directions.

isotropic material—a material whose properties do not vary with direction.

isotropy—having the same properties in all directions. (ISRM)

jackhammer—an air driven percussion drill that imparts a rotary hammering motion to the bit and has a passageway to the bit for the injection of compressed air for cleaning the hole of cuttings.

DISCUSSION—These two characteristics distinguish it from the pavement breaker which is similar in size and general appearance.

jack-leg—a portable percussion drill of the jack-hammer type, used in underground work; has a single pneumatically adjustable leg for support.

jet grouting—technique utilizing a special drill bit with horizontal and vertical high speed water jets to excavate alluvial soils and produce hard impervious columns by pumping grout through the horizontal nozzles that jets and mixes with foundation material as the drill bit is withdrawn.

jetting—when applied as a drilling method, water is forced down through the drill rods or casings and out through the end aperture. The jetting water then transports the generated cuttings to the ground surface in the annulus of the drill rods or casing and the borehole. The term jetting may also refer to a development technique (see **well screen jetting**). **D 5092**

jetty—an elongated artificial obstruction projecting into a body of water from a bank or shore to control shoaling and scour by deflection of the force of water currents and waves.

joint—a break of geological origin in the continuity of a body of rock occurring either singly, or more frequently in a set or system, but not attended by a visible movement parallel to the surface of discontinuity. (ISRM)

joint diagram—a diagram constructed by accurately plotting the strike and dip of joints to illustrate the geometrical relationship of the joints within a specified area of geologic investigation. (ISRM)

joint pattern—a group of joints that form a characteristic geometrical relationship, and which can vary considerably from one location to another within the same geologic formation. (ISRM)

joint (fault) set—a group of more or less parallel joints. (ISRM)

joint (fault) system—a system consisting of two or more joint sets or any group of joints with a characteristic pattern, that is, radiating, concentric, etc. (ISRM)

jumbo—a specially built mobile carrier used to provide a work platform for one or more tunneling operations, such as drilling and loading blast holes, setting tunnel supports, installing rock bolts, grouting, etc.

$\mathbf{K_{xy}}$—hydraulic conductivity in the horizontal plane, radially from the control well. **D 4106**

kaolin—a variety of clay containing a high percentage of kaolinite.

kaolinite—a common clay mineral having the general formula $Al_2(Si_2O_5)(OH_4)$; the primary constituent of kaolin.

karst—a geologic setting where cavities are developed in massive limestone beds by solution of flowing water. Caves and even underground river channels are produced into which surface runoff drains and often results in the land above being dry and relatively barren. (ISRM)

kelly—a heavy-wall tube or pipe, usually square or hexagonal in cross section, which works inside the matching center hole in the rotary table of a drill rig to impart rotary motion to the drill string.

lagging, *n*—*in mining or tunneling*, short lengths of timber, sheet steel, or concrete slabs used to secure the roof and sides of an opening behind the main timber or steel supports. The process of installation is also called lagging or lacing.

laminar flow (streamline flow) (viscous flow)—flow in which the head loss is proportional to the first power of the velocity.

landslide—the perceptible downward sliding or movement of a mass of earth or rock, or a mixture of both. (ISRM)

landslide (slide)—the failure of a sloped bank of soil or rock in which the movement of the mass takes place along a surface of sliding.

leaching—the removal in solution of the more soluble materials by percolating or moving waters. (ISRM)

leaching—the removal of soluble soil material and colloids by percolating water.

leakage, *n*—the flow of liquid from one hydrogeolic unit to another.

DISCUSSION—the leakage may be natural, as through semi-impervious confining layer, or man-made, as through an uncased well.

leakance, *n* (T^{-1})—the ratio K′/b′, in which K′ and b′ are the vertical hydraulic conductivity and the thickness, respectively, of the confining beds.

leaky aquifier, *n*—aquifiers, whether artesian or unconfined, that lose or gain water through adjacent less permeable beds.

lime—specifically, calcium oxide (CaO_2); also loosely, a general term for the various chemical and physical forms of quicklime, hydrated lime, and hydraulic hydrated lime.

ledge—see **bedrock**.

linear (normal) strain—the change in length per unit of length in a given direction. (ISRM)

line of creep (path of percolation)—the path that water follows along the surface of contact between the foundation soil and the base of a dam or other structure.

line of seepage (seepage line) (phreatic line)—the upper free water surface of the zone of seepage.

linear expansion, L_e (D)—the increase in one dimension of a soil mass, expressed as a percentage of that dimension at the shrinkage limit, when the water content is increased from the shrinkage limit to any given water content.

linear shrinkage, L_s (D)—decrease in one dimension of a soil mass, expressed as a percentage of the original dimension, when the water content is reduced from a given value to the shrinkage limit.

lineation—the parallel orientation of structural features that are lines rather than planes; some examples are parallel orientation of the long dimensions of minerals; long axes of pebbles; striae on slickensides; and cleavage-bedding plane intersections. (ISRM)

liquefaction—the process of transforming any soil from a solid state to a liquid state, usually as a result of increased pore pressure and reduced shearing resistance.

liquefaction potential—the capability of a soil to liquefy or develop cyclic mobility.

liquefaction (spontaneous liquefaction)—the sudden large decrease of the shearing resistance of a cohesionless soil. It is caused by a collapse of the structure by shock or other type of strain and is associated with a sudden but temporary increase of the prefluid pressure. It involves a temporary transformation of the material into a fluid mass.

liquid level—the level of liquid in a borehole or well at a particular time. The liquid level can be reported as an elevation or as a depth below the top of the land surface. If the liquid in ground water is known as water level. **D 4750**

liquid, limit, *LL*, L_w, w_L (D)—(*a*) the water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil.

(*b*) the water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of ½in. (12.7 mm) under the impact of 25 blows in a standard liquid limit apparatus.

liquid phase—contaminant residing as a liquid in vadose zone pore space, often referred to as "free product." **D 5314**

liquidity index (water-plasticity ratio) (relative water content), *B*, R_w, I_L (D)—the ratio, expressed as a percentage, of: (*1*) the natural water content of a soil minus its plastic limit, to (*2*) its plasticity index.

liquid-volume measurement—*in grouting*, measurement of grout on the basis of the total volume of solid and liquid constituents.

lithology—the description of rocks, especially sedimentary clastics and especially in hand specimens and in outcrops, on the basis of such characteristics as color, structures, mineralogy, and particle size.

loam—a mixture of sand, silt, or clay, or a combination of any of these, with organic matter (see **humus**).

DISCUSSION—It is sometimes called topsoil in contrast to the subsoils that contain little or no organic matter.

local shear failure—see **shear failure**.

loess—a uniform aeolian deposit of silty material having an open structure and relatively high cohesion due to cementation of clay or calcareous material at grain contacts.

DISCUSSION—A characteristic of loess deposits is that they can stand with nearly vertical slopes.

logarithmic decrement—the natural logarithm of the ratio of any two successive amplitudes of like sign, in the decay of a single-frequency oscillation.

longitudinal rod wave—see **compression wave**.

longitudinal wave, v_l (LT^{-1})—wave in which direction of displacement at each point of medium is normal to wave front, with propagation velocity, calculated as follows:

$$y_l = \sqrt{(E/\rho)[(1-\nu)/(1+\nu)(1-2\nu)\,]} = \sqrt{(\lambda+2\mu)/\rho} \qquad (4)$$

where:

E = Young's modulus,
ρ = mass density,
λ and μ = Lamé's constants, and
ν = Poisson's ratio.

long wave (quer wave), W (LT^{-1})—dispersive surface wave with one horizontal component, generally normal to the direction of propagation, which decreases in propagation velocity with increase in frequency.

losing stream, *n*—a stream or reach of a stream in which water flows from the stream bed into the ground.

DISCUSSION—synonymous with influent stream.

loss of circulation—the loss of drilling fluid into strata to the extent that circulation does not return to the surface. **D 5092**

lubricity—*in grouting*, the physico-chemical characteristic of

a grout material flow through a soil or rock that is the inverse of the inherent friction of that material to the soil or rock; comparable to "wetness."

lugeon—a measure of permeability defined by a pump-in test or pressure test, where one Lugeon unit is a water take of 1 L/min per metre of hole at a pressure of 10 bars.

lysimeter—a device to measure the quantity or rate of water movement through a block of soil, usually undisturbed or in-situ; or to collect such percolated water for analyses. **D 4696**

macropore—interaggregate cavities that service as the principal avenues for the infiltration and drainage of water and for aeration. **D 4696**

macroporosity—large intergranular porosity with large pore throats, including soil cracks, moldic porosity, animal burrows and other significant void space. **D 5314**

major principal plane—see **principal plane**.

major principal stress—see **stress**.

manifold—see **grout header**.

marl—calcareous clay, usually containing from 35 to 65 % calcium carbonate ($CaCO_3$).

marsh—a wetland characterized by grassy surface mats which are frequently interspersed with open water or by a closed canopy of grasses, sedges, or other herbacious plants.

mass unit weight—see **unit weight**.

mathematical model—the representation of a physical system by mathematical expressions from which the behavior of the system can be deduced with known accuracy. (ISRM)

matric potential—the energy required to extract water from a soil against the capillary and adsorptive forces of the soil matrix. **D 4696**

matric suction—for isothermal soil systems, matric suction is the pressure difference across a membrane separating soil solution, in-place, from the same bulk (see **soil-water pressure**). **D 4696**

matrix—*in grouting*, a material in which particles are embedded, that is, the cement paste in which the fine aggregate particles of a grout are embedded.

maximum amplitude (L, LT^{-1}, LT^{-2})—deviation from mean or zero point.

maximum density (*maximum unit weight*)—see **unit weight**.

mechanical analysis—see **grain-size analysis**.

mesic peat—see **hemic peat**.

metering pump—a mechanical arrangement that permits pumping of the various components of a grout system in any desired proportions or in fixed proportions. (*Syn.* proportioning pump, variable proportion pump.)

micropore—intraaggregate capillaries responsible for the retention of water and solutes. **D 4696**

microporosity—intragranular porosity and microscopic intergranular porosity with submicroscopic pore throats. **D 5314**

microseism—seismic pulses of short duration and low amplitude, often occurring previous to failure of a material or structure. (ISRM)

minor principal plane—see **principal plane**.

minor principal stress—see **stress**.

mixed-in-place pile—a soil-cement pile, formed in place by forcing a grout mixture through a hollow shaft into the ground where it is mixed with the in-place soil with an auger-like head attached to the hollow shaft.

mixer—a machine employed for blending the constituents of grout, mortar, or other mixtures.

mixing cycle—the time taken for the loading, mixing, and unloading cycle.

mixing speed—the rotation rate of a mixer drum or of the paddles in an open-top, pan, or trough mixer, when mixing a batch; expressed in revolutions per minute.

modifier—*in grouting*, an additive used to change the normal chemical reaction or final physical properties of a grout system.

modulus of deformation—see **modulus of elasticity**.

modulus of elasticity (modulus of deformation), *E, M* (FL^{-2})—the ratio of stress to strain for a material under given loading conditions; numerically equal to the slope of the tangent or the secant of a stress-strain curve. The use of the term **modulus of elasticity** is recommended for materials that deform in accordance with Hooke's law; the term **modulus of deformation** for materials that deform otherwise.

modulus of subgrade reaction—see **coefficient of subgrade reaction**.

modulus of volume change—see **coefficient of volume compressibility**.

Mohr circle—a graphical representation of the stresses acting on the various planes at a given point.

Mohr circle of stress (strain)—a graphical representation of the components of stress (strain) acting across the various planes at a given point, drawn with reference to axes of normal stress (strain) and shear stress (strain). (ISRM)

Mohr envelope—the envelope of a sequence of Mohr circles representing stress conditions at failure for a given material. (ISRM)

Mohr envelope (rupture envelope) (rupture line)—the envelope of a series of Mohr circles representing stress conditions at failure for a given material.

DISCUSSION—According to Mohr's rupture hypothesis, a rupture envelope is the locus of points the coordinates of which represent the combinations of normal and shearing stresses that will cause a given material to fail.

moisture content—see **water content.**

moisture-density curve—see **compaction curve**.

moisture-density test—see **compaction test**.

moisture equivalent:

centrifuge moisture equivalent, W_e, CME (D)—the water content of a soil after it has been saturated with water and then subjected for 1 h to a force equal to 1000 times that of gravity.

field moisture equivalent, FME—the minimum water content expressed as a percentage of the weight of the oven-dried soil, at which a drop of water placed on a smoothed surface of the soil will not immediately be absorbed by the soil but will spread out over the surface and give it a shiny appearance.

monitoring well (observation well)—a special well drilled in a selected location for observing parameters such as liquid

level or pressure changes or for collecting liquid samples. The well may be cased or uncased, but if cased the casing should have openings to allow flow of borehole liquid into or out of the casing. **D 4750**

montmorillonite—a group of clay minerals characterized by a weakly bonded sheet-like internal molecular structure; consisting of extremely finely divided hydrous aluminum or magnesium silicates that swell on wetting, shrink on drying, and are subject to ion exchange.

muck—stone, dirt, debris, or useless material; or an organic soil of very soft consistency.

mud—a mixture of soil and water in a fluid or weakly solid state.

mudjacking—see **slab jacking**.

mud pit—usually a shallow, rectangular, open, portable container with baffles into which drilling fluid and cuttings are discharged from a borehole and that serves as a reservoir and settling tank during recirculation of the drilling fluids. Under some circumstances, an excavated pit with a lining material may be used. **D 5092**

multibench blasting—the blasting of several benches (steps) in quarries and open pits, either simultaneously or with small delays. (ISRM)

multi-cased well—a well constructed by using successively smaller diameter casings with depth. **D 5092**

multiple-row blasting—the drilling, charging, and firing of several rows of vertical holes along a quarry or opencast face. (ISRM)

multiple-screened wells—two or more monitoring wells situated in the same borehole. These devices can be either individual casing strings and screen set at a specific depth, a well with screens in more than one zone, or can consist of devices with screens with tubing or other collecting devices attached that can collect a discrete sample. **D 5299**

muskeg—level, practically treeless areas supporting dense growth consisting primarily of grasses. The surface of the soil is covered with a layer of partially decayed grass and grass roots which is usually wet and soft when not frozen.

mylonite—a microscopic breccia with flow structure formed in fault zones. (ISRM)

native material—in place geologic (or soil) materials encountered at a site. **D 5299**

natural frequency—the frequency at which a body or system vibrates when unconstrained by external forces. (ISRM)

natural frequency (displacement resonance) f_n—frequency for which phase angle is 90° between the direction of the excited force (or torque) vector and the direction of the excited excursion vector.

neat cement grout—a mixture of hydraulic cement and water without any added aggregate or filler materials.

DISCUSSION—This may or may not contain admixture.

neutral stress—see **stress**.

newtonian fluid—a true fluid that tends to exhibit constant viscosity at all rates of shear.

node—point, line, or surface of standing wave system at which the amplitude is zero.

non-sample contacting equipment—related equipment associated with the sampling effort, but that does not directly contact the sample (for example, augers, drilling rods, excavations machinery). **D 5088**

normal force—a force directed normal to the surface element across which it acts. (ISRM)

normal stress—see **stress**.

normally consolidated soil deposit—a soil deposit that has never been subjected to an effective pressure greater than the existing overburden pressure.

no-slump grout—grout with a slump of 1 in. (25 mm) or less according to the standard slump test (Test Method C 143).[2] See also **slump** and slump test.

observation well—typically, a small diameter well used to measure changes in hydraulic head, usually in response to a nearby pumping well. **D 5092**

occluded vapor phase—condition of contaminant residence in which volatilized contaminants occur in porosity that is ineffective to free and open gaseous flow and exchange, such porosity generally being microporosity; frequently termed dead-end pore space. **D 5314**

oil air filter—a filter or series of filters placed in the air flow line from an air compressor to reduce the oil content of the air. **D 5092**

oil trap—a device used to remove oil from the compressed air discharged from an air compressor. **D 5092**

open cut—an excavation through rock or soil made through a hill or other topographic feature to facilitate the passage of a highway, railroad, or waterway along an alignment that varies in topographic relief. An open cut can be comprised of single slopes or multiple slopes, or multiple slopes and horizontal benches, or both. (ISRM)

optimum moisture content (optimum water content), *OMC*, w_o (D)—the water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

organic clay—a clay with a high organic content.

organic silt—a silt with a high organic content.

organic soil—soil with a high organic content.

DISCUSSION—In general, organic soils are very compressible and have poor load-sustaining properties.

organic terrain—see **peatland**.

oscillation—the variation, usually with time, of the magnitude of a quantity with respect to a specified reference when the magnitude is alternately greater and smaller than the reference.

outcrop—the exposure of the bedrock at the surface of the ground. (ISRM)

overbreak—the quantity of rock that is excavated or breaks out beyond the perimeter specified as the finished excavated tunnel outline. (ISRM)

overburden—the loose soil, sand, silt, or clay that overlies bedrock. In some usages it refers to all material overlying the point of interest (tunnel crown), that is, the total cover of soil and rock overlying an underground excavation. (ISRM)

overburden load—the load on a horizontal surface underground due to the column of material located vertically above it. (ISRM)

[2] *Annual Book of ASTM Standards*, Vol 04.02.

overconsolidated soil deposit—a soil deposit that has been subjected to an effective pressure greater than the present overburden pressure.

overconsolidation ratio, OCR—the ratio of preconsolidation vertical stress to the current effective overburden stress.

overdamped-well response—characterized by the water level returning to the static level in an approximately exponential manner following a sudden change in water level (see for comparison **underdamped well response**). **D 4044, D 4104**

overdrilling—the process of drilling out a well casing and any material placed in the annular space. **D 5299**

packer—*in grouting,* a device inserted in a hole in which grout or water is to be injected which acts to prevent return of the grout or water around the injection pipe; usually an expandable device actuated mechanically, hydraulically, or pneumatically.

packer (monitoring wells)—a transient or dedicated device placed in a well that isolates or seals a portion of the well, well annulus, or borehole at a specific level. **D 5092**

paddle mixer—a mixer consisting essentially of a trough within which mixing paddles revolve about the horizontal axis, or a pan within which mixing blades revolve about the vertical axis.

pan mixer—a mixer comprised of a horizontal pan or drum in which mixing is accomplished by means of the rotating pan of fixed or rotating paddles, or both; rotation is about a vertical axis.

parent material—material from which a soil has been derived.

particle-size analysis—see **grain-size analysis**.

particle-size distribution—see **gradation, grain-size distribution**.

particulate grout—any grouting material characterized by undissolved (insoluble) particles in the mix. See also **chemical grout**.

particulate solid—synonym for **bulk solid**.

partitioning—the act of movement of contaminants from one soil residence phase to another. **D 5314**

passive earth pressure—see **earth pressure**.

passive state of plastic equilibrium—see **plastic equilibrium**.

path percolation (line of creep)—the path that water follows along the surface of contact between the foundation soil or rock and the base of a dam or other structure.

pavement pumping—ejection of soil and water mixtures from joints, cracks, and edges of rigid pavements, under the action of traffic.

peak shear strength—maximum shear strength along a failure surface. (ISRM)

peat—a naturally occurring highly organic substance derived primarily from plant materials.

DISCUSSION—Peat is distinguished from other organic soil materials by its lower ash content (less than 25 % ash by dry weight) and from other phytogenic material of higher rank (that is, lignite coal) by its lower calorific value on a water saturated basis.

peatland—areas having peat-forming vegetation on which peak has accumulated or is accumulating.

penetrability—a grout property descriptive of its ability to fill a porous mass; primarily a function of lubricity and viscosity.

penetration—depth of hole cut in rock by a drill bit. (ISRM)

penetration grouting—filling joints or fractures in rock or pore spaces in soil with a grout without disturbing the formation; this grouting method does not modify the solid formation structure. See also **displacement grouting**.

penetration resistance (standard penetration resistance) (Proctor penetration resistance), p_R, N (FL^{-2} or Blows L^{-1})—(*a*) number of blows of a hammer of specified weight falling a given distance required to produce a given penetration into soil of a pile, casing, or sampling tube.

(*b*) unit load required to maintain constant rate of penetration into soil of a probe or instrument.

(*c*) unit load required to produce a specified penetration into soil at a specified rate of a probe or instrument. For a Proctor needle, the specified penetration is 2½ in. (63.5 mm) and the rate is ½ in. (12.7 mm)/s.

penetration resistance curve (Proctor penetration curve)—the curve showing the relationship between: (*1*) the penetration resistance, and (*2*) the water content.

percent compaction—the ratio, expressed as a percentage, of: (*1*) dry unit weight of a soil, to (*2*) maximum unit weight obtained in a laboratory compaction test.

percent consolidation—see **degree of consolidation**.

percent fines—amount, expressed as a percentage by weight, of a material in aggregate finer than a given sieve, usually the No. 200 (74 μm) sieve.

percent saturation (degree of saturation), S_rS_r(D)—the ratio, expressed as a percentage, of: (*1*) the volume of water in a given soil or rock mass, to (*2*) the total volume of intergranular space (voids).

perched ground water—unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

perched water table—a water table usually of limited area maintained above the normal free water elevation by the presence of an intervening relatively impervious confining stratum.

perched water table—groundwater separated from an underlying body of groundwater by unsaturated soil or rock. Usually located at a higher elevation than the groundwater table. (ISRM)

percolation—the movement of gravitational water through soil (see **seepage**).

percolation—the movement of water through the vadose zone, in contrast to infiltration at the land surface and recharge across a water table. **D 4696**

percussion drilling—a drilling technique that uses solid or hollow rods for cutting and crushing the rock by repeated blows. (ISRM)

percussion drilling—a drilling process in which a hole is advanced by using a series of impacts to the drill steel and attached bit; the bit is normally rotated during drilling. See **rotary drilling**.

perforation—a slot or hole made in well casing to allow for communication of fluids between the well and the annular space. **D 5299**

period—time interval occupied by one cycle.

permafrost—perennially frozen soil.

permanent plugging—a seal that has a hydraulic conductivity that is equivalent or less than the hydraulic conductivity of the geologic formation. This term is often used with uncased boreholes. **D 5299**

permanent strain—the strain remaining in a solid with respect to its initial condition after the application and removal of stress greater than the yield stress (commonly also called "residual" strain). (ISRM)

permeability—see **coefficient of permeability**.

permeability—the capacity of a rock to conduct liquid or gas. It is measured as the proportionality constant, *k*, between flow velocity, *v*, and hydraulic gradient, *I*; $v = k \cdot I$. (ISRM)

permeability intrinsic, n (L^{-3})—a measure of the ease with which a porous medium can transmit a fluid under a potential gradient.

DISCUSSION—Intrinsic permeability is a property of the medium alone and is independent of the nature of the fluid and of the force field causing movement.

permeation grouting—filling joints or fractures in rock or pore spaces in soil with a grout, without disturbing the formation.

pH, *pH* (D)—an index of the acidity or alkalinity of a soil in terms of the logarithm of the reciprocal of the hydrogen ion concentration.

phase difference—difference between phase angles of two waves of same frequency.

phase of periodic quantity—fractional part of period through which independent variable has advanced, measured from an arbitrary origin.

phreatic line—the trace of the phreatic surface in any selected plane of reference.

phreatic line—see **line of seepage**.

phreatic surface—see **free water elevation**.

phreatic water—see **free water**.

piezometer—a device used to measure head at a point in the subsurface. **D 5269**

piezometric line (equipotential line)—line along which water will rise to the same elevation in piezometric tubes.

piezometric surface—the surface at which water will stand in a series of piezometers.

piezometric surface—an imaginary surface that everywhere coincides with the static level of the water in the aquifer. (ISRM)

pile—relatively slender structural element which is driven, or otherwise introduced, into the soil, usually for the purpose of providing vertical or lateral support.

pillar—in-situ rock between two or more underground openings: crown pillars; barrier pillars; rib pillars; sill pillars; chain pillars; etc. (ISRM)

pilot drift (pioneer tunnel)—a drift or tunnel first excavated as a smaller section than the dimensions of the main tunnel. A pilot drift or tunnel is usually used to investigate rock conditions in advance of the main tunnel, to permit installation of bracing before the principal mass of rock is removed, or to serve as a drainage tunnel. (ISRM)

piping—the progressive removal of soil particles from a mass by percolating water, leading to the development of channels.

pit—an excavation in the surface of the earth from which ore is obtained as in large open pit mining or as an excavation made for test purposes, that is, a testpit. (ISRM)

plane of weakness—surface or narrow zone with a (shear or tensile) strength lower than that of the surrounding material. (ISRM)

plane stress (strain)—a state of stress (strain) in a solid body in which all stress (strain) components normal to a certain plane are zero. (ISRM)

plane wave—wave in which fronts are parallel to plane normal to direction of propagation.

plastic deformation—see **plastic flow**.

plastic equilibrium—state of stress within a soil or rock mass or a portion thereof, which has been deformed to such an extent that its ultimate shearing resistance is mobilized.

active state of plastic equilibrium—plastic equilibrium obtained by an expansion of a mass.

passive state of plastic equilibrium—plastic equilibrium obtained by a compression of a mass.

plastic flow (plastic deformation)—the deformation of a plastic material beyond the point of recovery, accompanied by continuing deformation with no further increase in stress.

plasticity—the property of a soil or rock which allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.

plasticity—property of a material to continue to deform indefinitely while sustaining a constant stress. (ISRM)

plasticity index, I_p, *PI*, I_w (D)—numerical difference between the liquid limit and the plastic limit.

plasticizer—in grouting, a material that increases the plasticity of a grout, cement paste, or mortar.

plastic limit, w_p, *PL*, P_w (D)—(*a*) the water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil. (*b*) water content at which a soil will just begin to crumble when rolled into a thread approximately ⅛ in. (3.2 mm) in diameter.

plastic soil—a soil that exhibits plasticity.

plastic state (plastic range)—the range of consistency within which a soil or rock exhibits plastic properties.

plow layer—the depth typically reached by a plow or other commonly used earth turning device used in agriculture. This depth is commonly one to two feet (0.3 to 0.61 m) below land surface. **D 5299**

plugging material—a material that has a hydraulic conductivity equal to or less than that of the geologic formation(s) to be sealed. Typical materials include portland cement and bentonite. **D 5299**

Poisson's ratio, (*v*)—ratio between linear strain changes perpendicular to and in the direction of a given uniaxial stress change.

pore-liquid—liquid that occupies an open space between solid soil particles. Within this guide, pore-liquid is limited to aqueous pore-liquid; that includes water and its solutes. **D 4696**

pore-liquid tension—see **matric-suction** or **soil water pressure**. **D 4696**

pore pressure (*pore water pressure*)—see **neutral stress** under stress.

pore water—water contained in the voids of the soil or rock.

porosity, *n* (D)—the ratio, usually expressed as a percentage, of: (*1*) the volume of voids of a given soil or rock mass, to (*2*) the total volume of the soil or rock mass.

porosity—the ratio of the aggregate volume of voids or interstices in a rock or soil to its total volume. (ISRM)

portal—the surface entrance to a tunnel. (ISRM)

positive displacement pump—a pump that will continue to build pressure until the power source is stalled if the pump outlet is blocked.

potential drop, Δh (L)—the difference in total head between two equipotential lines.

potentiometric surface—an imaginary surface representing the static head of ground water. The water table is a particular potentiometric surface.

DISCUSSION—Where the head varies with depth in the aquifer, a potentiometric surface is meaningful only if it describes the static head along a particular specified surface or stratus in that aquifer. More than one potentiometric surface is required to describe the distribution of head in this case. **D 5092**

powder—synonym for **bulk solid**, particularly when the particles of the bulk solid are fine.

power spectral density—the limiting mean-square value (for example, of acceleration, velocity, displacement, stress, or other random variable) per unit bandwidth, that is the limit of the mean-square value in a given rectangular bandwidth divided by the bandwidth, as the bandwidth approaches zero.

pozzolan—a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

pre-conditioning—an activity conducted prior to placing plugging material into a borehole in order to stabilize the hole. **D 5299**

preconsolidation pressure (prestress), p_e (FL^{-2})—the greatest effective pressure to which a soil has been subjected.

preplaced aggregate concrete—concrete produced by placing coarse aggregate in a form and later injecting a portland cement-sand or resin grout to fill the interstices.

pressure, p (FL^{-2})—the load divided by the area over which it acts.

pressure bulb—the zone in a loaded soil or rock mass bounded by an arbitrarily selected isobar of stress.

pressure head—the head of water at a point in a porous system; negative for unsaturated systems, positive for saturated systems. Quantitatively, it is the water pressure divided by the specific weight of water. **D 4696**

pressure testing—a method of permeability testing with water or grout pumped downhole under pressure.

pressure-void ratio curve (compression curve)—a curve representing the relationship between effective pressure and void ratio of a soil as obtained from a consolidation test. The curve has a characteristic shape when plotted on semilog paper with pressure on the log scale. The various parts of the curve and extensions to the parts of the curve and extensions to the parts have been designated as recompression, compression, virgin compression, expansion, rebound, and other descriptive names by various authorities.

pressure washing—the cleaning of soil or rock surfaces accomplished by injection of water, air, or other liquids, under pressure.

primary consolidation (*primary compression*) (*primary time effect*)—see **consolidation**.

primary filter pack—a clean silica sand or sand and gravel mixture of selected grain size and gradation that is installed in the annular space between the borehole wall and the well screen, extending an appropriate distance above the screen, for the purpose of retaining and stabilizing the particles from the adjacent strata. The term is used in place of gravel pack. **D 5092**

primary hole—*in grouting*, the first series of holes to be drilled and grouted, usually at the maximum allowable spacing.

primary lining—the lining first placed inside a tunnel or shaft, usually used to support the excavation. The primary lining may be of wood or steel sets with steel or wood lagging or rock bolts and shot-crete. (ISRM)

primary permeability—internal permeability of intack rock; intergranular permeability (not permeability due to fracturing).

primary porosity—the porosity that developed during the final stages of sedimentation or that was present within sedimentary particles at the time of deposition.

primary state of stress—the stress in a geological formation before it is disturbed by man-made works. (ISRM)

principal plane—each of three mutually perpendicular planes through a point in a soil mass on which the shearing stress is zero.

intermediate principal plane—the plane normal to the direction of the intermediate principal stress.

major principal plane—the plane normal to the direction of the major principal stress.

minor principal plane—the plane normal to the direction of the minor principal stress.

principal stress—see **stress**.

principal stress (strain)—the stress (strain) normal to one of three mutually perpendicular planes on which the shear stresses (strains) at a point in a body are zero. (ISRM)

Proctor compaction curve—see **compaction curve**.

Proctor penetration curve—see **penetration resistance curve**.

Proctor penetration resistance—see **penetration resistance**.

profile—see **soil profile**.

progressive failure—failure in which the ultimate shearing resistance is progressively mobilized along the failure surface.

progressive failure—formation and development of localized fractures which, after additional stress increase, eventually form a continuous rupture surface and thus lead to failure after steady deterioration of the rock. (ISRM)

proportioning pump—see **metering pump**.

proprietary—made and marketed by one having the exclusive right to manufacture and sell; privately owned and managed.

protective filter—see **filter**.

PTFE tape—joint sealing tape composed of polytetrafluoroethylene. **D 5092**

pumpability—*in grouting*, a measure of the properties of a particular grout mix to be pumped as controlled by the equipment being used, the formation being injected, and the engineering objective limitations.

pumping of pavement (*pumping*)—see **pavement pumping**.

pumping test—a field procedure used to determine in situ permeability or the ability of a formation to accept grout.

pure shear—a state of strain resulting from that stress condition most easily described by a Mohr circle centered at the origin. (ISRM)

quality assurance/quality control (QA/QC)—the efforts completed to evaluate the accuracy and precision of a sampling or testing procedure, or both. **D 5088**

quarry—an excavation in the surface of the earth from which stone is obtained for crushed rock or building stone. (ISRM)

Quer-wave (love wave), *W*—dispersive surface wave with one horizontal component, generally normal to the direction of propagation, which decreases in propagation velocity with increase in frequency.

quick condition (quicksand)—condition in which water is flowing upwards with sufficient velocity to reduce significantly the bearing capacity of the soil through a decrease in intergranular pressure.

quick test—see **unconsolidated undrained test**.

radius of influence of a well—distance from the center of the well to the closest point at which the piezometric surface is not lowered when pumping has produced the maximum steady rate of flow.

raise—upwardly constructed shaft; that is, an opening, like a shaft, made in the roof of one level to reach a level above. (ISRM)

range (of a deformation-measuring instrument)—the amount between the maximum and minimum quantity an instrument can measure without resetting. In some instances provision can be made for incremental extension of the range.

Rayleigh wave, v_R (LT^{-1})—dispersive surface wave in which element has retrograding elliptic orbit with one major vertical and one minor horizontal component both in plane of propagation velocity:

$$v_R = \alpha v_t \text{ with } 0.910 < \alpha < 0.995 \text{ for } 0.25 < \nu < 0.5 \quad (5)$$

reactant—*in grouting*, a material that reacts chemically with the base component of grout system.

reactive aggregate—an aggregate containing siliceous material (usually in amorphous or crypto-crystalline state) which can react chemically with free alkali in the cement.

DISCUSSION—The reaction can result in expansion of the hardened material, frequently to a damaging extent.

reflected (or refracted) wave—components of wave incident upon second medium and reflected into first medium (or refracted) into second medium.

reflection and refraction loss—that part of transmitted energy lost due to nonuniformity of mediums.

refusal—*in grouting*, when the rate of grout take is low, or zero, at a given pressure.

relative consistency, I_c, C_r (D)—ratio of: (*1*) the liquid limit minus the natural water content, to (*2*) the plasticity index.

relative density, D_d, I_D (D)—the ratio of (*1*) the difference between the void ratio of a cohesionless soil in the loosest state and any given void ratio, to (*2*) the difference between the void ratios in the loosest and in the densest states.

relative water content—see **liquidity index**.

remodeled soil—soil that has had its natural structure modified by manipulation.

remolding index, I_R (D)—the ratio of: (*1*) the modulus of deformation of a soil in the undisturbed state, to (*2*) the modulus of deformation of the soil in the remolded state.

remodeling sensitivity (sensitivity ratio), S_t (D)—the ratio of: (*1*) the unconfined compressive strength of an undisturbed specimen of soil, to (*2*) the unconfined compressive strength of a specimen of the same soil after remolding at unaltered water content.

residual drawdown—the difference between the projected prepumping water-level trend and the water level in a well or piezometer after pumping or injection has stopped. **D 5269**

residual soil—soil derived in place by weathering of the underlying material.

residual strain—the strain in a solid associated with a state of residual stress. (ISRM)

residual stress—stress remaining in a solid under zero external stress after some process that causes the dimensions of the various parts of the solid to be incompatible under zero stress, for example, (*1*) deformation under the action of external stress when some parts of the body suffer permanent strain; or (*2*) heating or cooling of a body in which the thermal expansion coefficient is not uniform throughout the body. (ISRM)

resin—*in grouting*, a material that usually constitutes the base of an organic grout system.

resin grout—a grout system composed of essentially resinous materials such as epoxys, polyesters, and urethanes.

DISCUSSION—In Europe, this refers to any chemical grout system regardless of chemical origin.

resolution (of a deformation-measuring instrument)—the ratio of the smallest divisional increment of the indicating scale to the sensitivity of the instrument. Interpolation within the increment may be possible, but is not recommended in specifying resolution.

resonance—the reinforced vibration of a body exposed to the vibration, at about the frequency, of another body.

resonant frequency—a frequency at which resonance exists.

response—the motion (or other output) in a device or system resulting from an excitation (stimulus) under specified conditions.

retard—bank-protection structure designed to reduce the riparian velocity and induce silting or accretion.

retardation—delay in deformation. (ISRM)

retarder—a material that slows the rate at which chemical reactions would otherwise occur.

reverse circulation—a drilling system in which the circulating medium flows down through the annulus and up through the

drill rod, that is, in the reverse of the normal direction of flow.

revetment—bank protection by armor, that is, by facing of a bank or embankment with erosion-resistant material.

Richard's outflow principle—the principle that states that pore-liquid will not generally flow into an air-filled cavity (at atmospheric pressure) in unsaturated soil. **D 4696**

riprap stone—material generally less than 2 tons (1814 kg) in mass, specially selected and graded, when properly placed prevent erosion through minor wave action, or strong currents and thereby preserves the shape of a surface, slope, or underlying structure.

rise time (pulse rise time)—the interval of time required for the leading edge of a pulse to rise from some specified small fraction to some specified larger fraction of the maximum value.

riser—the pipe extending from the well screen to or above the ground surface. **D 5092**

rock—natural solid mineral matter occurring in large masses or fragments.

rock—any naturally formed aggregate of mineral matter occurring in large masses or fragments. (ISRM)

rock anchor—a steel rod or cable installed in a hole in rock; in principle the same as rock bolt, but generally used for rods longer than about four metres. (ISRM)

rock bolt—a steel rod placed in a hole drilled in rock used to tie the rock together. One end of the rod is firmly anchored in the hole by means of a mechanical device or grout, or both, and the threaded projecting end is equipped with a nut and plate that bears against the rock surface. The rod can be pretensioned. (ISRM)

rock burst—a sudden and violent expulsion of rock from its surroundings that occurs when a volume of rock is strained beyond the elastic limit and the accompanying failure is of such a nature that accumulated energy is released instantaneously.

rock burst—sudden explosive-like release of energy due to the failure of a brittle rock of high strength. (ISRM)

rock flour—see **silt**.

rock mass—rock as it occurs in situ, including its structural discontinuities. (ISRM)

rock mechanics—the application of the knowledge of the mechanical behavior of rock to engineering problems dealing with rock. Rock mechanics overlaps with structural geology, geophysics, and soil mechanics.

rock mechanics—theoretical and applied science of the mechanical behaviour of rock. (ISRM)

roof—top of excavation or underground opening, particularly applicable in bedded rocks where the top surface of the opening is flat rather than arched. (ISRM)

rotary drilling—a drilling process in which a hole is advanced by rotation of a drill bit under constant pressure without impact. See **percussion drilling**.

round—a set of holes drilled and charged in a tunnel or quarry that are fired instantaneously or with short-delay detonators. (ISRM)

running ground—*in tunneling*, a granular material that tends to flow or "run" into the excavation.

rupture—that stage in the development of a fracture where instability occurs. It is not recommended that the term rupture be used in rock mechanics as a synonym for fracture. (ISRM)

rupture envelope (*rupture line*)—see **Mohr envelope**.

sagging—usually occurs in sedimentary rock formations as a separation and downward bending of sedimentary beds in the roof of an underground opening. (ISRM)

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

sample contacting equipment—equipment that comes in direct contact with the sample or portion of sample that will undergo chemical analyses or physical testing (for example, ground water well bailer, split-spoon sampler, soil gas sampling probe). **D 5088**

sand—particles of rock that will pass the No. 4 (4.75-mm) sieve and be retained on the No. 200 (75-μm) U.S. standard sieve.

sand boil—the ejection of sand and water resulting from piping.

sand equivalent—a measure of the amount of silt or clay contamination in fine aggregate as determined by test (Test Method D 2419).[3]

sanded grout—grout in which sand is incorporated into the mixture.

sapric peat—peat in which the original plant fibers are highly decomposed (less than 33 % fibers).

saturated unit weight—see **unit weight**.

saturation curve—see **zero air voids curve**.

scattering loss—that part of transmitted energy lost due to roughness of reflecting surface.

schistosity—the variety of foliation that occurs in the coarser-grained metamorphic rocks and is generally the result of the parallel arrangement of platy and ellipsoidal mineral grains within the rock substance. (ISRM)

secant modulus—slope of the line connecting the origin and a given point on the stress-strain curve. (ISRM)

secondary consolidation (*secondary compression*) (*secondary time effect*)—see **consolidation**.

secondary filter pack—a clean, uniformly graded sand that is placed in the annulus between the primary filter pack and the over-lying seal, or between the seal and overlying grout backfill, or both, to prevent movement of seal or grout, of both, into the primary filter pack. **D 5092**

secondary hole—*in grouting*, the second series of holes to be drilled and grouted usually spaced midway between primary holes.

secondary lining—the second-placed, or permanent, structural lining of a tunnel, which may be of concrete, steel, or masonry. (ISRM)

secondary state of stress—the resulting state of stress in the rock around man-made excavations or structures. (ISRM)

sediment basin—a structure created by construction of a barrier or small dam-like structure across a waterway or by excavating a basin or a combination of both to trap or restrain sediment.

[3] *Annual Book of ASTM Standards*, Vol 04.03.

sediment sump—a blank extension beneath the well screen used to collect fine-grained material from the filter pack and adjacent strata. The term is synonymous with rat trap or tail pipe. **D 5092**

seep—a small area where water oozes from the soil or rock.

seepage—the infiltration or percolation of water through rock or soil to or from the surface. The term seepage is usually restricted to the very slow movement of ground water. (ISRM)

seepage (percolation)—the slow movement of gravitational water through the soil or rock.

seepage face, *n*—a boundary between the saturated flow field and the atmosphere along which a subsurface liquid discharges, either by evaporation or movement "downhill" along the land surface or in a well as a thin film in response to the force of gravity.

seepage force—the frictional drag of water flowing through voids or interstices in rock, causing an increase in the intergranular pressure, that is, the hydraulic force per unit volume of rock or soil which results from the flow of water and which acts in the direction of flow. (ISRM)

seepage force, *J* (F)—the force transmitted to the soil or rock grains by seepage.

seepage line—see **line of seepage**.

seepage line, *n*—the uppermost level at which a flowing liquid emerges along a seepage face.

seepage velocity, V_a, $V_1(LT^{-1})$—the rate of discharge of seepage water through a porous medium per unit area of void space perpendicular to the direction of flow.

segregation—*in grouting*, the differential concentration of the components of mixed grout, resulting in nonuniform proportions in the mass.

seismic support—mass (heavy) supported on springs (weak) so that mass remains almost at rest when free end of springs is subjected to sinusoidal motion at operating frequency.

seismic velocity—the velocity of seismic waves in geological formations. (ISRM)

seismometer—instrument to pick up linear (vertical, horizontal) or rotational displacement, velocity, or acceleration.

self-stressing grout—expansive-cement grout in which the expansion induces compressive stress in grout if the expansion movement is restrained.

sensitivity—the effect of remolding on the consistency of a cohesive soil.

sensitivity (of an instrument)—the differential quotient dQ_0/dQ_1, where Q_0 is the scale reading and Q_1 is the quantity to be measured.

sensitivity (of a transducer)—the differential quotient dQ_0/dQ_1, where Q_0 is the output and Q_1 is the input.

series grouting—similar to stage grouting, except each successively deeper zone is grouted by means of a newly drilled hole, eliminating the need for washing grout out before drilling the hole deeper.

set—*in grouting*, the condition reached by a cement paste, or grout, when it has lost plasticity to an arbitrary degree, usually measured in terms of resistance to penetration or deformation; initial set refers to first stiffening and final set refers to an attainment of significant rigidity.

setting shrinkage—*in grouting*, a reduction in volume of grout prior to the final set of cement caused by bleeding, by the decrease in volume due to the chemical combination of water with cement, and by syneresis.

set time—(*1*) the hardening time of portland cement; or (*2*) the gel time for a chemical grout.

shaft—generally a vertical or near vertical excavation driven downward from the surface as access to tunnels, chambers, or other underground workings. (ISRM)

shaking test—a test used to indicate the presence of significant amounts of rock flour, silt, or very fine sand in a fine-grained soil. It consists of shaking a pat of wet soil, having a consistency of thick paste, in the palm of the hand; observing the surface for a glossy or livery appearance; then squeezing the pat; and observing if a rapid apparent drying and subsequent cracking of the soil occurs.

shear failure (failure by rupture)—failure in which movement caused by shearing stresses in a soil or rock mass is of sufficient magnitude to destroy or seriously endanger a structure.

general shear failure—failure in which the ultimate strength of the soil or rock is mobilized along the entire potential surface of sliding before the structure supported by the soil or rock is impaired by excessive movement.

local shear failure—failure in which the ultimate shearing strength of the soil or rock is mobilized only locally along the potential surface of sliding at the time the structure supported by the soil or rock is impaired by excessive movement.

shear force—a force directed parallel to the surface element across which it acts. (ISRM)

shear plane—a plane along which failure of material occurs by shearing. (ISRM)

shear resistance—see **internal friction**.

shear strain—the change in shape, expressed by the relative change of the right angles at the corner of what was in the undeformed state an infinitesimally small rectangle or cube. (ISRM)

shear strength, *s*, T_f (FL^{-2})—the maximum resistance of a soil or rock to shearing stresses. See **peak shear strength**.

shear strength—(monitoring wells) a measure of the shear or gel properties of a drilling fluid or grout. **D 5092**

shear stress, τ—a stress acting parallel to the surface of the plane being considered.

shear stress—stress directed parallel to the surface element across which it acts. (ISRM)

shear stress (*shearing stress*) (*tangential stress*)—see **stress**.

shear test—an experiment to determine the flow properties of a bulk solid by applying different states of stress and strain to it.

shear tester—an apparatus for performing shear tests.

shear wave (rotational, equivoluminal)—wave in which medium changes shape without change of volume (shear-plane wave in isotropic medium is transverse wave).

shelf life—maximum time interval during which a material may be stored and remain in a usable condition; usually related to storage conditions.

shock pulse—a substantial disturbance characterized by a rise

of acceleration from a constant value and decay of acceleration to the constant value in a short period of time.

shock wave—a wave of finite amplitude characterized by a shock front, a surface across which pressure, density, and internal energy rise almost discontinuously, and which travels with a speed greater than the normal speed of sound. (ISRM)

shotcrete—mortar or concrete conveyed through a hose and pneumatically projected at high velocity onto a surface. Can be applied by a "wet" or "dry" mix method. (ISRM)

shrinkage-compensating—*in grouting*, a characteristic of grout made using an expansive cement in which volume increase, if restrained, induces compressive stresses that are intended to offset the tendency of drying shrinkage to induce tensile stresses. See also **self-stressing grout**.

shrinkage index, *SI* (D)—the numerical difference between the plastic and shrinkage limits.

shrinkage limit, *SL*, w_s (D)—the maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass.

shrinkage ratio, *R* (D)—the ratio of: (*1*) a given volume change, expressed as a percentage of the dry volume, to (*2*) the corresponding change in water content above the shrinkage limit, expressed as a percentage of the weight of the oven-dried soil.

sieve analysis—determination of the proportions of particles lying within certain size ranges in a granular material by separation on sieves of different size openings.

silo—synonym for **bin**.

silt (inorganic silt) (rock flour)—material passing the No. 200 (75-μm) U.S. standard sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air-dried.

silt size—that portion of the soil finer than 0.02 mm and coarser than 0.002 mm (0.05 mm and 0.005 mm in some cases).

simple shear—shear strain in which displacements all lie in one direction and are proportional to the normal distances of the displaced points from a given reference plane. The dilatation is zero. (ISRM)

single-cased well—a monitoring well constructed with a riser but without an exterior casing. **D 5092**

single-grained structure—see **soil structure**.

size effect—influence of specimen size on its strength or other mechanical parameters. (ISRM)

skin friction, f (FL^{-2})—the frictional resistance developed between soil and an element of structure.

slabbing—the loosening and breaking away of relatively large flat pieces of rock from the excavated surface, either immediately after or some time after excavation. Often occurring as tensile breaks which can be recognized by the subconchoidal surfaces left on remaining rock surface. (ISRM)

slabjacking—*in grouting*, injection of grout under a concrete slab in order to raise it to a specified grade.

slaking—deterioration of rock on exposure to air or water.

slaking—the process of breaking up or sloughing when an indurated soil is immersed in water.

sleeved grout pipe—see **tube A manchette**.

sliding—relative displacement of two bodies along a surface, without loss of contact between the bodies. (ISRM)

slope—the excavated rock surface that is inclined to the vertical or horizontal, or both, as in an open-cut. (ISRM)

slow test—see **consolidated-drain test**.

sludge—a water charged sedimentary deposit.

DISCUSSION—the water-formed sedimentary deposit may include all suspended solids carried by the water and trace elements that were in solution in the water. Sludge usually does not cohere sufficiently to retain its physical shape when mechanical means are used to remove it from the surface on which it deposits, but it may be baked in place and be adherent. **D 4700**

slug—a volume of water or solid object used to induce a sudden change of head in a well. **D 4044, D 4104**

slump—a measure of consistency of freshly mixed concrete or grout. See also **slump test**.

slump test—the procedure for measuring slump (Test Method C 143).[2]

slurry cutoff wall—a vertical barrier constructed by excavating a vertical slot under a bentonite slurry and backfilling it with materials of low permeability for the purpose of the containment of the lateral flow of water and other fluids.

slurry grout—a fluid mixture of solids such as cement, sand, or clays in water.

slurry trench—a trench that is kept filled with a bentonite slurry during the excavation process to stabilize the walls of the trench.

slush grouting—application of cement slurry to surface rock as a means of filling cracks and surface irregularities or to prevent slaking; it is also applied to riprap to form grouted riprap.

smooth (-wall) blasting—a method of accurate perimeter blasting that leaves the remaining rock practically undamaged. Narrowly spaced and lightly charged blastholes, sometimes alternating with empty dummy holes, located along the breakline and fired simultaneously as the last round of the excavation. (ISRM)

soil (earth)—sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.

soil binder—see **binder**.

soil-forming factors—factors, such as parent material, climate, vegetation, topography, organisms, and time involved in the transformation of an original geologic deposit into a soil profile.

soil gas—vadose zone atmosphere. **D 5314**

soil horizon—see **horizon**.

soil mechanics—the application of the laws and principles of mechanics and hydraulics to engineering problems dealing with soil as an engineering material.

soil physics—the organized body of knowledge concerned with the physical characteristics of soil and with the methods employed in their determinations.

soil profile (profile)—vertical section of a soil, showing the nature and sequence of the various layers, as developed by deposition or weathering, or both.

soil stabilization—chemical or mechanical treatment designed to increase or maintain the stability of a mass of soil or otherwise to improve its engineering properties.

soil structure—the arrangement and state of aggregation of soil particles in a soil mass.

flocculent structure—an arrangement composed of flocs of soil particles instead of individual soil particles.

honeycomb structure—an arrangement of soil particles having a comparatively loose, stable structure resembling a honeycomb.

single-grained structure—an arrangement composed of individual soil particles; characteristic structure of coarse-grained soils.

soil suspension—highly diffused mixture of soil and water.

soil texture—see **gradation**.

soil-water pressure—the pressure on the water in a soil-water system, as measured by a piezometer for a saturated soil, or by a tensiometer for an unsaturated soil. **D 4696**

solute phase—a condition of contaminant residence in which contaminants are dissolved in ground water in either the saturated or the vadose zone. **D 5314**

solution cavern—openings in rock masses formed by moving water carrying away soluble materials.

sorbed phase—a condition of contaminant residence in which contaminants are adsorbed into the surface of soil particles or absorbed by soil organic matter. **D 5314**

sounding well—*in grouting*, a vertical conduit in a mass of coarse aggregate for preplaced aggregate concrete which contains closely spaced openings to permit entrance of grout.

DISCUSSION—The grout level is determined by means of a measuring line on a float within the sounding well.

spacing—the distance between adjacent blastholes in a direction parallel to the face. (ISRM)

spalling—(*1*) longitudinal splitting in uniaxial compression, or (*2*) breaking-off of plate-like pieces from a free rock surface. (ISRM)

specific capacity—the rate of discharge from a well divided by the drawdown of the water level within the well at a specific time since pumping started. **D 4043**

specific discharge, n (LT^1)—the rate of flow of water through a porous medium per unit area measured at a right angle to the direction of flow.

specific gravity:

specific gravity of solids, G, G_s, S_s (D)—ratio of: (*1*) the weight in air of a given volume of solids at a stated temperature to (*2*) the weight in air of an equal volume of distilled water at a stated temperature.

apparent specific gravity, G_a, S_a (D)—ratio of: (*1*) the weight in air of a given volume of the impermeable portion of a permeable material (that is, the solid matter including its impermeable pores or voids) at a stated temperature to (*2*) the weight in air of an equal volume of distilled water at a stated temperature.

bulk specific gravity (*specific mass gravity*), G_m, S_m (D)—ratio of: (*1*) the weight in air of a given volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to (*2*) the weight in air of an equal volume of distilled water at a stated temperature.

specific storage—the volume of water released from or taken into storage per unit volume of the porous medium per unit change in head. **D 4043, D 4050, D 4104, D 4105, D 5269**

specific surface (L^{-1})—the surface area per unit of volume of soil particles.

specific storage, n (L^{-1})—the volume of water released from or taken into storage per unit volume of the porous medium per unit change in head.

specific yield—the ratio of the volume of water that the saturated rock or soil will yield by gravity to the volume of the rock or soil. In the field, specific yield is generally determined by tests of unconfined aquifers and represents the change that occurs in the volume of water in storage per unit area of unconfined aquifer as the result of a unit change in head. Such a change in storage is produced by the draining or filling of pore space and is, therefore, mainly dependent on particle size, rate of change of the water table, and time of drainage. **D 4043**

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

spherical wave—wave in which wave fronts are concentric spheres.

split spacing grouting—a grouting sequence in which initial (primary) grout holes are relatively widely spaced and subsequent grout holes are placed midway between previous grout holes to ″split the spacing.″; this process is continued until a specified hole spacing is achieved or a reduction in grout take to a specified value occurs, or both.

spring characteristics, c (FL^{-1})—ratio of increase in load to increase in deflection:

$$c = l/C \tag{6}$$

where:

C = compliance.

stability—the condition of a structure or a mass of material when it is able to support the applied stress for a long time without suffering any significant deformation or movement that is not reversed by the release of stress. (ISRM)

stability factor (stability number), N_s (D)—a pure number used in the analysis of the stability of a soil embankment, defined by the following equation:

$$N_s = H_c\gamma_e/c \tag{7}$$

where:

H_c = critical height of the sloped bank,
γ_e = effective unit of weight of the soil, and
c = cohesion of the soil

NOTE 1—Taylor's "stability number" is the reciprocal of Terzaghi's" stability factor."

stabilized borehole liquid level—the borehole liquid level which remains essentially constant with time, that is, liquid does not flow into or out of the borehole. **D 4750**

stabilization—see **soil stabilization**.

stage—*in grouting*, the length of hole grouted at one time. See also **stage grouting**.

stage grouting—sequential grouting of a hole in separate steps

or stages in lieu of grouting the entire length at once; holes may be grouted in ascending stages by using packers or in descending stages downward from the collar of the hole.

standard compaction—see **compaction test**.

standard penetration resistance—see **penetration resistance**.

standing wave—a wave produced by simultaneous transmission in opposite directions of two similar waves resulting in fixed points of zero amplitudes called nodes.

static water level—the elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage. **D 5092**

steady-state vibration—vibration in a system where the velocity of each particle is a continuing periodic quantity.

stemming—(*1*) the material (chippings, or sand and clay) used to fill a blasthole after the explosive charge has been inserted. Its purpose is to prevent the rapid escape of the explosion gases. (*2*) the act of pushing and tamping the material in the hole. (ISRM)

step-drawdown test—a test in which a control well is pumped at constant rates in "steps" of increasing discharge. Each step is approximately equal in duration, although the last step may be prolonged. **D 5269**

stick-slip—rapid fluctuations in shear force as one rock mass slides past another, characterized by a sudden slip between the rock masses, a period of no relative displacement between the two masses, a sudden slip, etc. The oscillations may be regular as in a direct shear test, or irregular as in a triaxial test.

sticky limit, T_w (D)—the lowest water content at which a soil will stick to a metal blade drawn across the surface of the soil mass.

stiffness—the ratio of change of force (or torque) to the corresponding change in translational (or rotational) deflection of an elastic element.

stiffness-force—displacement ratio. (ISRM)

stone—crushed or naturally angular particles of rock.

stop—*in grouting*, a packer setting at depth.

stop grouting—the grouting of a hole beginning at the lowest packer setting (stop) after the hole is drilled to total depth.

DISCUSSION—Packers are placed at the top of the zone being grouted. Grouting proceeds from the bottom up. Also called upstage grouting.

storage coefficient—the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. For a confined aquifer, the storage coefficient is equal to the product of the specific storage and aquifer thickness. For an unconfined aquifer, the storage coefficient is approximately equal to the specific yield. **D 4043, D 4044, D 4050, D 4104, D 4105, D 4106, D 5269**

strain, ϵ (D)—the change in length per unit of length in a given direction.

strain (linear or normal), ϵ (D)—the change in length per unit of length in a given direction.

strain ellipsoid—the representation of the strain in the form of an ellipsoid into which a sphere of unit radius deforms and whose axes are the principal axes of strain. (ISRM)

strain (stress) rate—rate of change of strain (stress) with time. (ISRM)

strain resolution (strain sensitivity), R_s (D)—the smallest subdivision of the indicating scale of a deformation-measuring device divided by the product of the sensitivity of the device and the gage length. The deformation resolution, R_d, divided by the gage length.

strain (stress) tensor—the second order tensor whose diagonal elements consist of the normal strain (stress) components with respect to a given set of coordinate axes and whose off-diagonal elements consist of the corresponding shear strain (stress) components. (ISRM)

streamline flow—see **laminar flow**.

strength—maximum stress which a material can resist without failing for any given type of loading. (ISRM)

stress, σ, *p*, *f* (FL^{-2})—the force per unit area acting within the soil mass.

effective stress (*effective pressure*) (*intergranular pressure*), $\bar{\sigma}$, *f* (FL^{-2})—the average normal force per unit area transmitted from grain to grain of a soil mass. It is the stress that is effective in mobilizing internal friction.

neutral stress (*pore pressure*) (*pore water pressure*), *u*, u_w (FL^{-2})—stress transmitted through the pore water (water filling the voids of the soil).

normal stress, σ, *p* (FL^{-2})—the stress component normal to a given plane.

principal stress, σ_1, σ_2, σ_3(FL^{-2})—stresses acting normal to three mutually perpendicular planes intersecting at a point in a body, on which the shearing stress is zero.

major principal stress, σ_1(FL^{-2})—the largest (with regard to sign) principal stress.

minor principal stress, σ_3(FL^{-2})—the smallest (with regard to sign) principal stress.

intermediate principal stress, σ_2(FL^{-2})—the principal stress whose value is neither the largest nor the smallest (with regard to sign) of the three.

shear stress (*shearing stress*) (*tangential stress*), τ, *s* FL^{-2})—the stress component tangential to a given plane.

total stress, σ, *f* (FL^{-2})—the total force per unit area acting within a mass of soil. It is the sum of the neutral and effective stresses.

stress ellipsoid—the representation of the state of stress in the form of an ellipsoid whose semi-axes are proportional to the magnitudes of the principal stresses and lie in the principal directions. The coordinates of a point *P* on this ellipse are proportional to the magnitudes of the respective components of the stress across the plane normal to the direction *OP*, where *O* is the center of the ellipsoid. (ISRM)

stress (strain) field—the ensemble of stress (strain) states defined at all points of an elastic solid. (ISRM)

stress relaxation—stress release due to creep. (ISRM)

strike—the direction or azimuth of a horizontal line in the plane of an inclined stratum, joint, fault, cleavage plane, or other planar feature within a rock mass. (ISRM)

structure—one of the larger features of a rock mass, like bedding, foliation, jointing, cleavage, or brecciation; also the sum total of such features as contrasted with texture. Also, in a broader sense, it refers to the structural features of an area such as anti-clines or synclines. (ISRM)

structure—see **soil structure**.

subbase—a layer used in a pavement system between the subgrade and base coarse, or between the subgrade and portland cement concrete pavement.

subgrade—the soil prepared and compacted to support a structure or a pavement system.

subgrade surface—the surface of the earth or rock prepared to support a structure or a pavement system.

submerged unit weight—see **unit weight**.

subsealing—*in grouting*, grouting under concrete slabs for the purpose of filling voids without raising the slabs.

subsidence—the downward displacement of the overburden (rock or soil, or both) lying above an underground excavation or adjoining a surface excavation. Also the sinking of a part of the earth's crust. (ISRM)

subsoil—(*a*) soil below a subgrade of fill. (*b*) that part of a soil profile occurring below the "A" horizon.

sulfate attack—*in grouting*, harmful or deleterious reactions between sulfates in soil or groundwater and the grout.

support—structure or structural feature built into an underground opening for maintaining its stability. (ISRM)

surface force—any force that acts across an internal or external surface element in a material body, not necessarily in a direction lying in the surface. (ISRM)

surface wave—a wave confined to a thin layer at the surface of a body. (ISRM)

suspension—a mixture of liquid and solid materials.

suspension agent—an additive that decreased the settlement rate of particles in liquid.

swamp—a forested or shrub covered wetland where standing or gently flowing water persists for long periods on the surface.

syneresis—*in grouting*, the exudation of liquid (generally water) from a set gel which is not stressed, due to the tightening of the grout material structure.

take—see **grout take**.

talus—rock fragments mixed with soil at the foot of a natural slope from which they have been separated.

tamper—a heavy cylindrical metal section of tubing that is operated on a wire rope or cable. It slips over the riser and fits inside the casing or borehole annulus. It is generally used to tamp annular sealants or filter pack materials into place and prevent bridging. **D 5092**

tangential stress—see **stress**.

tangent modulus—slope of the tangent to the stress-strain curve at a given stress value (generally taken at a stress equal to half the compressive strength). (ISRM)

target monitoring zone—the ground water flow path from a particular area or facility in which monitoring wells will be screened. The target monitoring zone should be a stratus (strata) in which there is a reasonable expectation that a vertically placed well will intercept migrating contaminants. **D 5092**

temporary decommissioning—the engineered closure of a well intended to be returned to service at some later date (generally no more than six months). Temporary plugging should not damage the structural integrity of the well. Plugging materials consist of sand, bentonite, or other easily removed materials. **D 5299**

tensile strength (unconfined or uniaxial tensile strength), T_o (FL^{-2})—the load per unit area at which an unconfined cylindrical specimen will fail in a simple tension (pull) test.

tensile stress—normal stress tending to lengthen the body in the direction in which it acts. (ISRM)

tensiometer—a device for measuring soil-water matric potential (or tension or suction) of water in soil in-situ; a porous, permeable ceramic cup connected through a water filled tube to a pressure measuring device. **D 4696**

test pit—a shallow excavation made to characterize the subsurface. **D 5092**

tertiary hole—*in grouting*, the third series of holes to be drilled and grouted usually spaced midway between previously grouted primary and secondary holes.

texture—*of soil and rock*, geometrical aspects consisting of size, shape, arrangement, and crystallinity of the component particles and of the related characteristics of voids.

texture—the arrangement in space of the components of a rock body and of the boundaries between these components. (ISRM)

theoretical time curve—see **consolidation time curve**.

thermal spalling—the breaking of rock under stresses induced by extremely high temperature gradients. High-velocity jet flames are used for drilling blast holes with this effect. (ISRM)

thermo-osmosis—the process by which water is caused to flow in small openings of a soil mass due to differences in temperature within the mass.

thickness—the perpendicular distance between bounding surfaces such as bedding or foliation planes of a rock. (ISRM)

thixotropy—the property of a material that enables it to stiffen in a relatively short time on standing, but upon agitation or manipulation to change to a very soft consistency or to a fluid of high viscosity, the process being completely reversible.

throw—the projection of broken rock during blasting. (ISRM)

thrust—force applied to a drill in the direction of penetration. (ISRM)

tight—rock remaining within the minimum excavation lines after completion of a blasting record. (ISRM)

till—see **glacial till**.

time angle of internal friction, ϕ_t—inclination of the time yield locus of the tangency - point with the Mohr stress circle passing through the origin.

time yield locus—the yield locus of a bulk solid which has remained at rest under a given normal stress for a certain time.

time curve—see **consolidation time curve**.

time factor, T_v, T (D)—dimensionless factor, utilized in the theory of consolidation, containing the physical constants of a soil stratum influencing its time-rate of consolidation, expressed as follows:

$$T = k\,(1 + e)t/(a_v\gamma_w{\cdot}H^2) = (c_v{\cdot}t)/H^2 \qquad (8)$$

where:

k = coefficient of permeability (LT^{-1}),

e = void ratio (dimensionless),

t = elapsed time that the stratum has been consolidated (T),
a_v = coefficient of compressibility (L^2F^{-1}),
γ_w = unit weight of water (FL^{-3}),
H = thickness of stratum drained on one side only. If stratum is drained on both sides, its thickness equals 2H (L), and
c_v = coefficient of consolidation (L^2T^{-1}).

top of borehole—the surface of the ground surrounding the borehole. **D 4750**

topsoil—surface soil, usually containing organic matter.

torsional shear test—a shear test in which a relatively thin test specimen of solid circular or annular cross-section, usually confined between rings, is subjected to an axial load and to shear in torsion. In-place torsion shear tests may be performed by pressing a dentated solid circular or annular plate against the soil and measuring its resistance to rotation under a given axial load.

total soil-water potential—the sum of the energy-related components of a soil-water system; for example, the sum of the gravitational, matrix and osmotic potentials. **D 4696**

total stress—see **stress**.

toughness index, I_T, T_w—the ratio of: (*1*) the plasticity index, to (*2*) the flow index.

traction, S_1, S_2, S_3(FL^{-2})—applied stress.

transformed flow net—a flow net whose boundaries have been properly modified (transformed) so that a net consisting of curvilinear squares can be constructed to represent flow conditions in an anisotropic porous medium.

transmissivity—the volume of water at the existing kinematic viscosity that will move in a unit time under a unit hydraulic gradient through a unit width of the aquifer. **D 4043, D 4050, D 4104, D 4105, D 4106, D 4631**

transmissivity—the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

DISCUSSION—It is equal to an integration of the hydraulic aconductivities across the saturated part of the aquifer perpendicular to the flow paths. **D 5092**

transmissivity—the volume of water of the prevailing kinematic viscosity transmitted in a unit time through a unit width of the aquifer under a unit hydraulic gradient. **D 5269**

transported soil—soil transported from the place of its origin by wind, water, or ice.

transverse wave, v_t (LT^{-1})—wave in which direction of displacement of element of medium is parallel to wave front. The propagation velocity, v_t, is calculated as follows:

$$v_t = \sqrt{G/\rho} = \sqrt{\mu/\rho} = \sqrt{(E/\rho)[1/2(1 + \nu)]} \quad (9)$$

where:
G = shear modulus,
ρ = mass density,
ν = Poisson's ratio, and
E = Young's modulus.

transverse wave (shear wave)—a wave in which the displacement at each point of the medium is parallel to the wave front. (ISRM)

tremie—material placed under water through a tremie pipe in such a manner that it rests on the bottom without mixing with the water.

tremie method—the method whereby materials are emplaced in the bottom of a borehole with a small diameter pipe. **D 4696**

trench—usually a long, narrow, near vertical sided cut in rock or soil such as is made for utility lines. (ISRM)

triaxial compression—compression caused by the application of normal stresses in three perpendicular directions. (ISRM)

triaxial shear test (triaxial compression test)—a test in which a cylindrical specimen of soil or rock encased in an impervious membrane is subjected to a confining pressure and then loaded axially to failure.

triaxial state of stress—state of stress in which none of the three principal stresses is zero. (ISRM)

true solution—one in which the components are 100 % dissolved in the base solvent.

tube A manchette—*in grouting*, a grout pipe perforated with rings of small holes at intervals of about 12 in. (305 mm).

DISCUSSION—Each ring of perforations is enclosed by a short rubber sleeve fitting tightly around the pipe so as to act as a one-way valve when used with an inner pipe containing two packer elements that isolate a stage for injection of grout.

tunnel—a man-made underground passage constructed without removing the overlying rock or soil. Generally nearly horizontal as opposed to a shaft, which is nearly vertical. (ISRM)

turbulent flow—that type of flow in which any water particle may move in any direction with respect to any other particle, and in which the head loss is approximately proportional to the second power of the velocity.

ultimate bearing capacity, q_e, q_{ult} (FL^{-2})—the average load per unit of area required to produce failure by rupture of a supporting soil or rock mass.

unconfined compressive strength—the load per unit area at which an unconfined prismatic or cylindrical specimen of material will fail in a simple compression test without lateral support.

unconfined aquifer, *n*—an aquifer that has a water table.

unconfined compressive strength—see **compressive strength**.

unconfined yield strength, f_c— the major principal stress of the Mohr stress circle being tangential to the yield locus with the minor principal stress being zero. A synonym for **compressive strength**.

unconsolidated-undrained test (quick test)—a soil test in which the water content of the test specimen remains practically unchanged during the application of the confining pressure and the additional axial (or shearing) force.

undamped natural frequency—*of a mechanical system*, the frequency of free vibration resulting from only elastic and inertial forces of the system.

underconsolidated soil deposit—a deposit that is not fully consolidated under the existing overburden pressure.

underdamped-well response—response characterized by the water level oscillating about the static water level following a sudden change in water level. (See for comparison **overdamped well response**.) **D 4044, D 4104**

undisturbed sample—a soil sample that has been obtained by methods in which every precaution has been taken to minimize disturbance to the sample.

uniaxial (unconfined) compression—compression caused by the application of normal stress in a single direction. (ISRM)

uniaxial state of stress—state of stress in which two of the three principal stresses are zero. (ISRM)

uniformly graded—a quantitative definition of the particle size distribution of a soil which consists of a majority of particles being of the same approximate diameter. A granular material is considered uniformly graded when the uniformity coefficient is less than about five (see Test Method D 2487). Comparable to the geologic term well sorted. **D 5092**

unit weight, γ (FL^{-3})—weight per unit volume (with this, and all subsequent unit-weight definitions, the use of the term weight means force).

dry unit weight (*unit dry weight*), γ_d, γ_e (FL^{-3})—the weight of soil or rock solids per unit of total volume of soil or rock mass.

effective unit weight, γ_e (FL^{-3})—that unit weight of a soil or rock which, when multiplied by the height of the overlying column of soil or rock, yields the effective pressure due to the weight of the overburden.

maximum unit weight, γ_{max}(FL^{-3})—the dry unit weight defined by the peak of a compaction curve.

saturated unit weight, γ_G, γ_{sat}(FL^{-3})—the wet unit weight of a soil mass when saturated.

submerged unit weight (*buoyant unit weight*), γ_m, γ', γ_{sub} (FL^{-3})—the weight of the solids in air minus the weight of water displaced by the solids per unit of volume of soil or rock mass; the saturated unit weight minus the unit weight of water.

unit weight of water, γ_w (FL^{-3})—the weight per unit volume of water; nominally equal to 62.4 lb/ft^3 or 1 g/cmt^3.

wet unit weight (*mass unit weight*), γ_m, γ_{wet} (FL^{-3})—the weight (solids plus water) per unit of total volume of soil or rock mass, irrespective of the degree of saturation.

zero air voids unit weight, γ_z, γ_s (FL^{-3})—the weight of solids per unit volume of a saturated soil or rock mass.

unloading modulus—slope of the tangent to the unloading stress-strain curve at a given stress value. (ISRM)

uplift—the upward water pressure on a structure.

	Symbol	Unit
unit symbol	*u*	FL^{-2}
total symbol	*U*	F or FL^{-1}

uplift—the hydrostatic force of water exerted on or underneath a structure, tending to cause a displacement of the structure. (ISRM)

uplift—*in grouting*, vertical displacement of a formation due to grout injection.

vacuum—a degree of rarefaction below atmospheric pressure: negative pressure. **D 4696**

vadose zone—the hydrogeological region extending from the soil surface to the top of the principle water table; commonly referred to as the "unsaturated zone" or "zone of aeration". These alternate names are inadequate as they do not take into account locally saturated regions above the principle water table (for example, perched water zones). **D 4696, D5314**

vane shear test—an in-place shear test in which a rod with thin radial vanes at the end is forced into the soil and the resistance to rotation of the rod is determined.

varved clay—alternating thin layers of silt (or fine sand) and clay formed by variations in sedimentation during the various seasons of the year, often exhibiting contrasting colors when partially dried.

vent hole—*in grouting*, a hole drilled to allow the escape of air and water and also used to monitor the flow of grout.

vent pipe—*in grouting*, a small-diameter pipe used to permit the escape of air, water, or diluted grout from a formation.

vented cap—a cap with a small hole that is installed on top of the riser. **D 5092**

vibrated beam wall (injection beam wall)—barrier formed by driving an H-beam in an overlapping pattern of prints and filling the print of the beam with cement-bentonite slurry or other materials as it is withdrawn.

vibration—an oscillation wherein the quantity is a parameter that defines the motion of a mechanical system (see **oscillation**).

virgin compression curve—see **compression curve**.

viscoelasticity—property of materials that strain under stress partly elastically and partly viscously, that is, whose strain is partly dependent on time and magnitude of stress. (ISRM)

viscosity—the internal fluid resistance of a substance which makes it resist a tendency to flow.

viscous damping—the dissipation of energy that occurs when a particle in a vibrating system is resisted by a force that has a magnitude proportional to the magnitude of the velocity of the particle and direction opposite to the direction of the particle.

viscous flow—see **laminar flow**.

void—space in a soil or rock mass not occupied by solid mineral matter. This space may be occupied by air, water, or other gaseous or liquid material.

void ratio, *e* (D)—the ratio of: (*1*) the volume of void space, to (*2*) the volume of solid particles in a given soil mass.

critical void ratio, e_c (D)—the void ratio corresponding to the critical density.

volumetric shrinkage (volumetric change), V_s (D)—the decrease in volume, expressed as a percentage of the soil mass when dried, of a soil mass when the water content is reduced from a given percentage to the shrinkage limit.

von Post humification scale—a scale describing various stages of decomposition of peat ranging from H1, which is completely undecomposed, to H10, which is completely decomposed.

wall friction, f' (FL^{-2})—frictional resistance mobilized between a wall and the soil or rock in contact with the wall.

wall yield locus—a plot of the wall shear stress versus wall normal stress. The angle of wall friction is obtained from the wall yield locus as the arctan of the ratio of the wall shear stress to wall normal stress.

washing—*in grouting*, the physical act of cleaning the sides of a hole by circulating water, water and air, acid washes, or chemical substances through drill rods or tremie pipe in an open hole.

washout nozzle—a tubular extension with a check valve

utilized at the end of a string of casing through which water can be injected to displace drilling fluids and cuttings from the annular space of a borehole. **D 5092**

water-cement ratio—the ratio of the weight of water to the weights of Portland cement in a cement grout or concrete mix. See also **grout mix**.

water content, *w* (D)—the ratio of the mass of water contained in the pore spaces of soil or rock material, to the solid mass of particles in that material, expressed as a percentage.

water gain—see **bleeding**.

water-holding capacity (D)—the smallest value to which the water content of a soil or rock can be reduced by gravity drainage.

water-plasticity ratio (*relative water content*) (*liquidity index*)—see **liquidity index**.

water table—see **free water elevation**.

water table (ground-water table)—the surface of a ground-water body at which the water pressure equals atmospheric pressure. Earth material below the ground-water table is saturated with water. **D 4750**

water table aquifer, *n*—see preferred term **unconfined aquifer**.

wave—disturbance propagated in medium in such a manner that at any point in medium the amplitude is a function of time, while at any instant the displacement at point is function of position of point.

wave front—moving surface in a medium at which a propagated disturbance first occurs.

wave front—(*1*) a continuous surface over which the phase of a wave that progresses in three dimensions is constant, or (*2*) a continuous line along which the phase of a surface wave is constant. (ISRM)

wave length—normal distance between two wave fronts with periodic characteristics in which amplitudes have phase difference of one complete cycle.

weathering—the process of disintegration and decomposition as a consequence of exposure to the atmosphere, to chemical action, and to the action of frost, water, and heat. (ISRM)

weep hole—a small diameter hole (usually ¼ in.) drilled into the protective casing above the ground surface that serves as a drain hole for water that may enter the protective casing annulus. **D 5092**

well completion diagram—a record that illustrates the details of a well installation. **D 5092**

well screen—a filtering device used to retain the primary or natural filter pack; usually a cylindrical pipe with openings of a uniform width, orientation, and spacing. **D 5092**

well screen jetting (hydraulic jetting)—when jetting is used for development, a jetting tool with nozzles and a high-pressure pump is used to force water outwardly through the screen, the filter pack, and sometimes into the adjacent geologic unit. **D 5092**

wetland—land which has the water table at, near, or above the land surface, or which is saturated for long enough periods to promote hydrophylic vegetation and various kinds of biological activity which are adapted to the wet environment.

wetting agent—a substance capable of lowering the surface tension of liquids, facilitating the wetting of solid surfaces, and facilitating the penetration of liquids into the capillaries.

wet unit weight—see **unit weight**.

working pressure—the pressure adjudged best for any particular set of conditions encountered during grouting.

DISCUSSION—Factors influencing the determination are size of voids to be filled, depth of zone to be grouted, lithology of area to be grouted, grout viscosity, and resistance of the formation to fracture.

yield—*in grouting*, the volume of freshly mixed grout produced from a known quantity of ingredients.

yielding arch—type of support of arch shape, the joints of which deform plastically beyond a certain critical load, that is, continue to deform without increasing their resistance. (ISRM)

yield locus—plot of shear stress versus normal stress at failure. The yield locus (YL) is sometimes called the instantaneous yield locus to differentiate it from the time yield locus.

yield stress—the stress beyond which the induced deformation is not fully annulled after complete destressing. (ISRM)

Young's modulus—the ratio of the increase in stress on a test specimen to the resulting increase in strain under constant transverse stress limited to materials having a linear stress-strain relationship over the range of loading. Also called elastic modulus.

zone of saturation—a hydrologic zone in which all the interstices between particles of geologic material or all of the joints, fractures, or solution channels in a consolidated rock unit are filled with water under pressure greater than that of the atmosphere. **D 5092**

zero air voids curve (saturation curve)—the curve showing the zero air voids unit weight as a function of water content.

zero air voids density (*zero air voids unit weight*)—see **unit weight**.

APPENDIX

(Nonmandatory Information)

X1. ISRM SYMBOLS RELATING TO SOIL AND ROCK MECHANICS

NOTE X1.1—These symbols may not correlate with the symbols appearing in the text.

X1.1 Space

Ω, ω	solid angle
l	length
b	width
h	height or depth
r	radius
A	area
V	volume
t	time
v	velocity
ω	angular velocity
g	gravitational acceleration

X1.2 Periodic and Related Phenomena

T	periodic time
f	frequency
ω	angular frequency
λ	wave length

X1.3 Statics and Dynamics

m	mass
ρ	density (mass density)
G_m	mass specific gravity
G_s	specific gravity of solids
G_w	specific gravity of water
F	force
T	tangential force
W	weight
γ	unit weight
γ_d	dry unit weight
γ_w	unit weight of water
γ'	buoyant unit weight
γ_s	unit of solids
T	torque
I	moment of inertia
W	work
W	energy

X1.4 Applied Mechanics

e	void ratio
n	porosity
w	water content
S_r	degree of saturation
p	pressure
u	pore water pressure
σ	normal stress
σ_x, σ_y, σ_z	stress components in rectangular coordinates
σ_1, σ_2, σ_3	principal stresses
S_1, S_2, S_3	applied stresses (and reactions)
σ_h	horizontal stress
σ_v	vertical stress
τ	shear stress
τ_{xy}, τ_{yz}, τ_{zx}	shear stress components in rectangular coordinates
ϵ	strain
ϵ_x, ϵ_y, ϵ_z	strain components in rectangular coordinates
γ_{xy}, γ_{yz}, γ_{zx}	shear strain components in rectangular coordinates
θ	volume strain
E	Young's modulus; modulus of elasticity $E = \sigma/\epsilon$
ϵ_1, ϵ_2, ϵ_3	principal strains
G	shear modulus; modulus of rigidity $G = \tau/\gamma$
c	cohesion
ϕ_s	angle of friction between solid bodies
ϕ	angle of shear resistance (angle of internal friction)
h	hydraulic head
i	hydraulic gradient
j	seepage force per unit volume or seepage pressure per unit length
k	coefficient of permeability
η	viscosity
η_{pl}	plasticity (viscosity of Bingham body)
t_{ret}	retardation time
t_{rel}	relaxation time
T_s	surface tension
q	quantity rate of flow; rate of discharge
Q	quantity of flow
FS	safety factor

X1.5 Heat

T	temperature
β	coefficient of volume expansion

X1.6 Electricity

I	electric current
Q	electric charge
C	capacitance
L	self-inductance
R	resistance
ρ	resistivity

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