

Glossary of Grouting Terminology

Grouting Committee of the Geo-Institute
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Abstract: This glossary is a compilation of terms used in the field of grouting, with an emphasis on the definitions that are specific to usage in grouting practice. It updates and replaces the corresponding Glossary contained in the July 1980 issue of the *Journal of the Geotechnical Engineering Division*.

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Introduction

This glossary is an attempt by the Grouting Committee to compile and standardize many of the terms used in the field of grouting so that communications about grouting projects, and interpretation of reports on grouting projects, can be understood and coordinated. It is an update of and a replacement for the Preliminary Glossary of Terms Relating to Grouting, which was published in the July 1980 issue of the *Journal of the Geotechnical Engineering Division*.

A

Absorption: The assimilation of fluids into interstices, e.g., water loss from unstable grout when injected into porous rock, or movement of chemical grout into sand.

Accelerator: A material that increases the rate at which chemical reactions in grout would otherwise occur.

Activator: A material that causes a chemical reaction to initiate in a grout, especially a resin grout or certain other chemical grouts.

Additive: Any material other than the basic components of a grout system. In ACI terminology, a general term for a material that may be used either as an addition to cement or an admixture in concrete.

Adhesion: Bond of unlike materials, such as bond of grout to rock joint surfaces, tunnel liner surfaces, or rock particles.

Admixture: A material other than water, aggregates, or cementitious material, used as a grout ingredient for cement-based grouts.

Advancing Slope Grouting: A method of grouting by which the front of a mass of grout is caused to move horizontally, for

example, through preplaced aggregate, by use of a suitable grout injection sequence.

Aggregate: Relatively inert granular mineral material, such as sand, gravel, crushed stone, etc., commonly used as a structural component or bulking agent in cement-based grout.

Agitator Tank: An open tank or hopper which is equipped with rotating mixing elements, used to maintain the mixed condition of the grout prior to its injection.

Alkali Aggregate Reaction: A chemical reaction between Na_2O and K_2O in the cement and certain silicate minerals in the aggregate, which causes expansion resulting in weakening and cracking of portland cement grout.

B

Backfill Grouting: Filling of large voids, such as those that may remain behind the supports or lagging of a mined tunnel following construction of the tunnel lining.

Backpack Grouting: Archaic term referring to the filling with grout of the annular space between a permanent tunnel lining and the surrounding formation. See contact grouting and backfill grouting.

Base: Main component in a grout system. Also, when referring to pH, an alkali.

Batch: Quantity of grout mixed at one time.

Batch Mixer: A machine that mixes batches of grout, in contrast to a continuous mixer.

Batch System: A grouting system in which a selected quantity of grout is mixed and/or catalyzed at one time prior to injection.

Bentonite: A clay composed principally of minerals of the montmorillonite group, characterized by high absorption and a very large volume change with wetting or drying. Commonly used as an additive in cement-based grouts.

Binder: A material, such as cement grout or clay, that causes cohesion in loosely assembled substances such as preplaced aggregate.

Blaine Fineness: A measure of the fineness of powdered materials such as cement and pozzolans. Usually expressed as square centimeters of surface area per gram.

Blanket Grouting: A procedure in which relatively closely spaced and usually shallow holes are drilled and grouted for the purpose of reducing the permeability of the upper portions of the bedrock beneath the site of an embankment dam. Generally but

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not necessarily done either on a grid pattern or in rows parallel to the grout curtain. Commonly includes "off-pattern" holes to treat selected geologic defects such as fracture or shear zones. Sometimes confused with or improperly considered to be synonymous with consolidation grouting.

Bleed: Separation of excess water from a particulate suspension grout as a result of settlement. Commonly expressed as a percentage of the initial volume of the mixed grout.

Bleeding: Exudation of water from grout, especially following injection. Depending upon the size of the opening, may be due to confining pressure, settlement of grout particles, or a combination of both.

Bleeding Rate: The rate at which water is released from grout by bleeding.

Bond Strength: Resistance to separation of set grout from surfaces such as bedrock joints, cracks in concrete, or tunnel lining material with which it is in contact.

C

Catalyst: A material that causes chemical reactions (such as gelation of chemical grouts or hardening of resin grouts) to begin, while theoretically not entering into the reaction.

Catalyst System: A group of materials that, in combination, cause chemical reactions to begin. Catalyst systems normally consist of an initiator (catalyst) and an activator.

Cellular Grout: Also called Cellular Foam Grout. A lightweight grout composed principally of cement and a natural or synthetic foam.

Cement Factor: The amount of cement, in terms of dry weight in pounds, that remains in the ground after mixing, per cubic yard of in situ soil-cement, which is also referred to as Residual Cement Factor.

Cement Grouting: The injection of hydraulic cement based grouts for the purpose of altering the properties of a soil or rock mass.

Chemical Grout: Any grouting material characterized by being a pure solution or, as in the case of sodium silicate-based grouts, a grout that contains such fine particles in suspension that it behaves essentially as a Newtonian or near Newtonian fluid during injection. See Particulate Grout.

Chemical Grout System: A lightweight grout composed principally of cement and a natural or synthetic foam.

Circuit Grouting: A grouting method by which grout is circulated through a pipe extending the bottom of the hole and back up the hole via the annular spaces outside the pipe, thence passing through a packing gland at the top of the hole and through a screen mounted on the agitator tank.

Closure: In curtain grouting, closure refers to achieving the desired reduction in grout take and permeability by progressively splitting the hole spacing. If closure is being achieved, there will be a progressive decrease in grout take and permeability as primary, secondary, tertiary, and higher order holes are grouted.

Cohesion: A physical property of grout which theoretically controls its ability to flow through fine fractures in bedrock. It is equivalent to the yield stress of a grout as measured in a viscometer.

Collar: The surface opening of a grout hole; usually the top of a casing or pipe nipple that has been grouted into the formation to which the grout delivery line is attached.

Colloid: A substance composed of fine particles that, follow-

ing vigorous mixing, do not settle out of an aqueous suspension. For example, sodium silicate.

Colloidal Grout: A grout in which the dispersed solid particles remain in suspension. (Term sometimes is applied to cement-based grouts formulated in a high speed/high shear mixer. However, no cement-based grouts are truly colloidal.)

Colloidal Mixer: Misnomer for a mixer that has been claimed to produce colloidal grout by means of repeatedly circulating the grout between rapidly rotating impeller disks in the pump or by circulating it through a pump chamber within which it is subjected to high turbulence. More properly called a "High Shear Mixer" in either case, as complete diminution of all grout material particles to colloidal size is unlikely to be achieved.

Communication: Grout travel through the subsurface from the injection location to another hole.

Compaction Grout: Grout injected with less than 1 in. (25 mm) slump. Normally a soil-cement with sufficient silt sizes to provide mobility together with sufficient sand and gravel sizes to develop sufficient internal friction to cause the grout to act as a growing mass as injection continues under pressure. The grout generally does not enter soil pores (except, perhaps, where open-work boulder gravels are present) but remains a homogeneous mass that gives controlled displacement to compact loose non-plastic soils, gives controlled displacement for lifting structures, or both.

Compensation Grouting: The introduction of a fluid or semi-fluid grout into the ground, increasing the local volume at the point of injection. This in turn causes movement by expansion of ground away from the area of injection, either compensating for movement in an opposing sense or causing movement to accumulate in the direction of expansion. Two processes have been traditionally used in conjunction with excavation for underground structures: **Soil Fracture Grouting** and **Compaction Grouting**.

Concrete, Preplaced Aggregate: Concrete produced by injecting a portland cement-based grout or resin grout to fill the interstices of coarse aggregate.

Consistency: 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.

Consolidation Grouting: In rock, consolidation grouting consists of injection of cement-based grout for the purpose of strengthening the rock mass by filling open fractures and thus eliminating a source of settlement. Incidental to this main purpose, consolidation grouting may also serve to reduce the uplift potential beneath concrete dams by reducing the permeability. Generally done by drilling and grouting shallow holes on a grid pattern in the foundation area of concrete dams but may include "off-pattern" holes to treat selected geologic defects such as fracture or shear zones. The term is commonly and improperly used as a synonym for blanket grouting.

Contact Grouting: The filling of relatively minor voids between a permanent tunnel lining and the surrounding formation, such as at the crown of a tunnel.

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.

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

Core Recovery: Ratio of the length of core recovered to the length of hole drilled, usually expressed as a percentage.

Cover: The thickness of rock and soil material overlying the stage of hole being grouted.

Creep: Time-dependent deformation due to load.

Cure Time: The time period between the injection of a grout and its hardening to a required strength level.

Curtain Grouting: Injection of grout into a subsurface formation in such a way as to create a zone of grouted material transverse to the direction of the anticipated water flow.

D

Deformability: A measure of the elasticity of the grout to distort in the interstitial spaces in response to movement of the enclosing soil or rock mass.

Dispersing Agent: An admixture, such as a high-range water reducing agent (also known as a superplasticizer) that promotes dispersion of particulate grout ingredients by reduction of interparticle attraction or by temporarily placing a repelling charge on the grout particles.

Displacement Grouting: Injection of grout into a formation in such a manner as to controllably displace or move the formation.

Drainage Curtain: A row of open holes drilled parallel to and downstream from the grout curtain of a concrete dam for the purpose of reducing uplift pressures. Also, sometimes built as a postconstruction remedial measure to intercept excessive seepage at the downstream toe of an embankment dam during or following first filling of a reservoir.

Drainage Gallery: A passageway from which grout holes or drainage holes, or both, are drilled. Most commonly constructed within the base of concrete dams, but—less commonly—within a concrete core block in the base of an embankment dam (for example, Oroville Dam).

Drill: A machine or piece of equipment designed to penetrate earth or rock formations, or both, using either rotary, rotary-percussive, sonic, or driving techniques.

Drill Mud: A 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. The most common drill mud for exploratory holes is a water-bentonite mixture. However, a polymer-based "mud" is preferred for drilling grout holes in unstable materials.

Dry Pack: Dry cement or a cement-sand mix with minimal water content used to repair imperfections in concrete or to fill small openings in rock foundations to control surface leakage during curtain, blanket, or consolidation grouting.

Dye Tracer: A dye injected into a subsurface location such as a dam foundation, or placed in an apparent seepage source location such as an apparent entry point at the upstream face of a dam, for the purpose of locating leakage paths preparatory to designing a remedial grouting program. (Note: use not limited to dam remediation applications.) Less commonly, an additive the primary purpose of which is to add a distinctive color to grout to facilitate its recognition.

E

Efflux Time: Time required for a measured volume (commonly 1 L) of grout to flow from a flow cone or funnel.

Electrokinetics: 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 potentially facilitating grout injection.

Emulsifier: A substance that modifies the surface tension of

colloidal droplets, keeping them from coalescing, and keeping them suspended.

Emulsion: A fluid system containing dispersed colloidal droplets.

Endothermic: Pertaining to a reaction, such as occurs in some polymer grouts, that absorbs heat.

Envelope Grouting: Grouting of rock surrounding a hydraulic pressure tunnel for the purpose of consolidation, and primarily, reduction of permeability.

Epoxy: A multicomponent resin grout that usually provides very high, tensile, compressive, and bond strengths.

Exothermic: Pertaining to a reaction, such as occurs during the hydration of portland cement in grout or concrete, that produces 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. Also known as filler.

F

Fineness: A measure of particle-size distribution.

Fineness Modulus: An empirical factor obtained by dividing the total percentage of an aggregate sample retained on 100 mesh (149 μm) and larger screens by 100.

Fines: In soil terminology, material that will pass a 200-mesh (74 μm) sieve.

Fishing Tool: A device used to retrieve equipment lost or dropped in a drill hole.

Fissure: An extensive crack, break, or fracture in rock or soil mass.

Flow Cone: 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. (A flow cone commonly used in grouting is described in ASTM Standard Test Method C 939.)

Fluidifier: An admixture, now more commonly known as a water reducing agent or plasticizer, employed in grout to increase flowability without changing water content.

Fly Ash: The finely divided coal combustion by-products (CCB) collected by electrostatic precipitators from the flue gases. Fly ash is an artificial pozzolan produced when pulverized coal is burned in electric power plants. The glassy (amorphous) spherical particulates are the active pozzolanic portion of fly ash. Fly ash is 66–68% glass. Class F fly ash (see ASTM C 618) readily reacts with lime (produced when portland cement hydrates) and alkalis to form cementitious compounds. Class C fly ash also may exhibit hydraulic (self-cementing) properties. Fly ash is a common ingredient in modern multicomponent, stable grouts.

Foam Grout: Grout that has been blended with a foaming agent during or following initial mixing in order to reduce its unit weight and/or to help reduce the cost of filling voids.

Fracture: A break or crack in a rock mass. In general, usage includes joints, however, the terms are sometimes used in conjunction to distinguish between joints—breaks that are relatively smooth and planar and usually occur in parallel sets, and fractures—breaks having rough irregular surfaces and generally random orientation.

Gauge Protector: A device used to transfer grout pressure to a gauge without the grout coming in actual contact with the gauge.

Gauge Saver: Same as Gauge Protector.

Gel: The condition in which a liquid grout begins to exhibit measurable shear strength, or in which the grout changes from a liquid to a plastic state.

Gel Time: The time that it takes for a liquid grout to exhibit measurable shear strength, or to change from a liquid or a plastic consistency.

Grout: In soil or rock grouting, a material injected into a soil or rock formation to change the physical characteristics of the formation. Grouts may be cementitious, chemical solutions, or of a variety of resinous origins.

Groutability: The ability of a rock or soil mass to accept grout.

Groutability Ratio (Of Granular Soils): The ratio of the 15% size of the formation particles to be grouted to the 85% size of the grout particles (suspension-type grout).

Groutable Rock Bolts: Rock bolts with hollow cores or with tubes attached to the periphery of the bolts and extending to the bottom of the bolts to facilitate filling the holes surrounding the bolts with grout after tensioning.

Grouted-Aggregate Concrete: Concrete that is formed by injecting grout into previously placed coarse aggregate. See also **Concrete, Preplaced Aggregate**.

Grout Cap: A "cap" that is formed by placing concrete on the foundation surface along the top of a grout curtain or incised within the foundation at the top of the curtain. In the former case, the cap functions to protect weak and/or decomposed foundation rock during movement of drilling and grouting equipment. In the latter case, the objective of the cap is to form an impermeable barrier in essentially ungroutable weak rock at the top of a grout curtain. In either case, the grout cap facilitates securing grout nipples.

Grout Gallery: An opening or passageway within and or beneath a dam, and/or in the abutments of a dam, utilized for grouting operations. (Depending upon the type and configuration of the dam and on the foundation geologic conditions, may also serve as a drainage and inspection gallery.) See also **Drainage Gallery**.

Grout Header: An assembly that mounts on a hole casing or standpipe and serves as a means of connection of the grout delivery line. Will commonly contain pressure gauges, valves, and other required control fittings.

Grout Mix: Also called the grout formulation, grout mix is a descriptive term referring to the types and relative proportions of the constituent ingredients of a given grout.

Grout Nipple: A short length of pipe, installed at the collar of a grout hole, through which drilling is done and to which the grout header may be attached for the purpose of injecting grout.

Grout Slope: The natural slope of grout injected into preplaced aggregate or other porous mass.

Grout Take: Volume of grout injected. May refer to the total volume injected in an interval within a hole, in an entire grout hole, in a unit length or area of a grout curtain or in the rock formation or soil mass as a whole. Also, may be expressed in terms of amount of grout injected per unit length of grout hole or curtain. Sometimes the volume referred to is the total volume of cement or solids rather than the fluid volume. However, in past US rock grouting practice the volume of cement or solids rather than the fluid volume has more commonly been used in the calculation of unit take.

Hardener: In a two component epoxy or resin grout, the chemical component that causes the base component to cure.

Heat of Hydration: Heat produced by chemical reactions with water, such as that evolved during the setting and hardening of portland cement.

High Mobility Grouting: Injection of grouts with low apparent viscosity, such as any of those typically used for permeation grouting.

Hydration: A chemical reaction between water and hydraulic cement which starts as soon as they come in contact with one another.

Hydraulic Fracturing: Fracturing of a soil or rock mass by the pressure of a fluid grout or a grout that behaves as a fluid when under pressure in the ground.

Hydrometer: A device used to measure the specific gravity of Newtonian fluids such as certain grouts.

Hydrophilic: Tendency of a material such as certain resin grouts to attract water.

Hydrophobic: Tendency of a material such as certain resin grouts to repel water.

Hydraulic Jacking: In the context of dam foundation grouting, injection of grout into preexisting openings, such as joints and fractures, at sufficient pressure to cause elastic (i.e., temporary) widening of those openings to facilitate entry of the grout. Also, displacement or uplift of an overlying or adjacent rock mass as a consequence of continued injection at pressure in excess of confining pressure.

Hydrofracture Grouting: Deliberate injection of grout at sufficiently high pressures to produce fractures in a weak formation to promote intrusion and distribution of the grout. Depending upon the nature of the formation and of the preexisting stresses, the grout may move out in fingers, sheets, and/or lenses. Most commonly done in alluvium, but also done in grouting practice for deep mines.

I

Inhibitor (Also called a retarder.): A material that stops or slows a chemical reaction from occurring. In cement grouting practice, a material that delays the start of hydration or that slows the rate of hydration.

J

Jet Grouting: A replacement/mixing technology that uses a tool equipped with one or more high-pressure jets to erode/cut (hydraulically excavate?) soils while mixing cement grout with the in situ soils, creating soil-cement columns or soil-cement panels. In general, the mixing tool is jetted to the final depth prior to initiating the cutting/mixing action. However, predrilled pilot holes are used for (1) work in hard and/or gravelly and cobbly soils that cannot be readily penetrated by the jetting/mixing nozzle, and (2) projects in which the required depth of treatment is such that a larger diameter hole is needed to reduce the escape pressure of spoils being evacuated from the hole.

Jet Grouting Terms

Single System: The jet grouting process in which the disaggregation and cementing of soil are achieved by a high energy jet of a single fluid, usually a cement grout.

Double (Air) System: The jet grouting process in which the disaggregation and the cementing of soil are achieved by one high energy fluid (usually a cement grout) assisted by an air jet shroud as a second fluid.

Double (Water) System: The jet grouting process in which the disaggregation of the soil is achieved by a high energy water jet and in which cementing is simultaneously obtained by a separate grout jet.

Triple System: The jet grouting process in which the disaggregation of the soils is achieved by a high energy water jet assisted by an air jet shroud, and its cementing is simultaneously obtained by a separate jet grout.

Horizontal Jet Grouting: Treatment performed from a horizontal or subhorizontal borehole (within $\pm 20^\circ$ from the horizontal plane).

Jet Grouting Rig: Rotary rig able to automatically regulate the rotation and translation of the jet grouting string and tool.

Jet Grouting String: Threaded and/or connectable rods, with simple, double, or triple inner conduit, which convey the jet grouting fluid(s) to the monitor.

Monitor: The tool mounted at the end of the jet grouting string, incorporating nozzle(s) to enable jetting of the fluids into the ground.

Nozzle: A specially manufactured device fitted into the monitor and designed to transform the high pressure fluid flow in the string into the high speed jet directed at the soil.

Radius of Influence: Effective distance of disaggregation of soil by the jet, measured from the axis of the monitor.

Spoil: The surplus mixture of soil particles and introduced fluids arising from the jet grouting process, and normally flowing to the ground surface via the annulus of the jetting borehole.

Jet Grouting Parameters: The jet grouting parameters include:

- Pressure of the fluid(s) within the jet grouting string;
- Flow rate of the fluid(s) within the jet grouting string;
- Grout composition;
- Rotation speed of the jet grouting string;
- Translation speed of the jet grouting nozzle; and
- Quantity of grout deposited per unit of hole length.

Jet Mixing: Use of the Venturi effect to form grout or drilling mud by drawing powered solids through a funnel into a fluid flowing at high velocity through a constricted channel.

Joint: In Geology—A fracture or parting that interrupts the physical continuity of a rock mass. Joints are relatively planar and usually occur in sets which are often subparallel to parallel. In Drilling—a single length, or the juncture between two connected lengths, of casing, drill rod, or grout pipe.

Joint Set: A group of more or less parallel joints in a rock mass.

Joint System: Two or more (commonly three) joint sets or any group of related joints with a characteristic pattern.

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.

K

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 import rotary motion to the drill string. (Also referred to as a "Kelly bar.")

L

Lime: Specifically, calcium oxide (CaO) also loosely, a general term of the various chemical and physical forms of quicklime, hydrated lime, and hydraulic hydrated lime. Acts as a stabilizing agent when in contact with clays due to a cation exchange. Forms a cementitious material when mixed with a pozzolan.

Liquid Volume Measurement: Measurement of grout on the basis of the total volume of solid and liquid constituents.

Low Mobility Grout (LMG): Low slump grout, such as compaction-type grout, that does not travel freely and that becomes immobile when injection pressure ceases.

Lubricity: The physiochemical 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." For fluid grouts it is the "wetability," which is a function of the contact angle of the grout to a given surface.

Lugeon: A measure of the permeability of a geological formation. One Lugeon unit = 1 L (of water) / meter of test hole / minute at an injection pressure of 10 bars (approximately 150 psi). The most common unit in which permeability is calculated by means of packer tests in conjunction with design or construction of grout curtains.

M

Marsh Funnel: A device used for the field measurement of apparent viscosity of drilling muds and high mobility grouts. Analogous to the flow cone that is used for thick mortars, but much smaller and more sensitive to small differences in apparent viscosity.

Matrix: A material filling or partially filling the interstices of a natural or artificial deposit or mass made up of coarser particles. The nature of the matrix can be a determining factor in groutability; e.g., a cobble gravel with a sand matrix may be groutable, but a cobble gravel with a clay matrix most likely would not be groutable.

Metering Pump: See **Proportioning Pump**.

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: One episode of loading the mixer, mixing, and unloading a batch of grout.

Mixing Speed: The rotation rate, expressed in revolutions per minute, of mixer paddles or pump impeller in a grout mixer.

Modifier: An additive used to change the normal chemical reaction or final physical properties of a grout.

Moyno Pump: See **Progressive Cavity Pump**.

Mud Balance: Device used for the field measurement of the density of drilling muds and high mobility grouts. Commonly used in conjunction with Marsh funnel measurements for field quality assurance verification of proper proportioning of slurry grouts.

Mudjacking: See **Slab Jacking**. (Mudjacking is a holdover term from earlier times when a clayey mud was the only grout that could be pumped. Cementitious grouts are now used almost exclusively, so the use of mud, which implies an inferior material, should be discouraged.)

N

Neat Cement Grout: A mixture of hydraulic cement and water without any added aggregate or filler materials; may or may not contain admixtures.

Newtonian Fluid: A true fluid that tends to exhibit constant viscosity at all rates of shear.

O

No grouting terms starting with the letter O are defined in this Glossary.

P

Packer: A device which, when inserted into a grout hole, acts to prevent return of the grout around the injection pipe during injection. Usually an expandable device, actuated mechanically, hydraulically, or pneumatically. (Also, see **Straddle Packer**).

Paddle Mixer: A grout mixer in which the mixing is accomplished by paddles rotating around a shaft. There are two basic types: a vertical cylindrical tub in which the paddle rotates on a vertical or slightly inclined shaft; and a horizontal trough, commonly with a semicylindrical base, in which the paddles rotate on a horizontal shaft.

Pan Mixer: Grout mixer comprised of a horizontal pan or drum in which mixing is accomplished by means of a rotating pan, rotating paddles, or both; rotation is about a vertical axis.

Particulate Grout: Any grout characterized by undissolved (insoluble) particles suspended in the mix. Also referred to as suspension grout or slurry grout.

Penetrability: A grout property descriptive of its ability to fill a porous mass. Primarily a function of lubricity and viscosity.

Penetration Grouting: Filling joints or fractures in rock or pore spaces in soil with a grout without disturbing the formation.

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**.

Permeation Grouting: Filling of voids in a soil or rock mass with a grout fluid at a low injection pressure to strengthen and/or reduce permeability, while not destroying the original structure of the soil or rock.

Piezometer: A device which is embedded in a drill hole to measure the soil pore pressure (pressure head of groundwater). In its simplest form, it may consist of an open hole or well penetrating the water table. In engineering work, it more often refers to a pressure cell that may be placed in a dam embankment, etc., as part of the permanent instrumentation.

Pig: Large pneumatic tanker or silo used to hold dry powder such as cement, bentonite, or fly ash. Also, a plug-like mass pumped through grout delivery lines to clean them and/or a tool pulled through pipes prior to grouting.

Plasticizer: A material that increases plasticity of a grout, cement paste, or mortar.

Porosity: The ratio of the volume of voids in a material to the total volume of the material including the voids, usually expressed as a percentage.

Pozzolan: A siliceous or siliceous and aluminous material, which in itself possess 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. Pozzolans commonly used as ingredients in grout include fly ash and silica fume.

Progressive Cavity Pump: A rotary pump (such as a Moyno pump) wherein a helical steel rotor rotates inside a softer stator. Spaces containing the grout advance along the rotor in a positive screwing motion resulting from the single-helix shape of the rotor and the double-helix shape of the stator.

Proportioning Pump: A pump that, together with one or more other pumps, is used in an arrangement that permits pumping of the various components of a grout system in any desired proportions or in fixed proportions.

Pumpability: A relative measure of the properties of a particular grout mix to be pumped, as limited by the equipment being used, including not only the pump but also the pipes, valves, and hoses through which the grout must pass.

Pumping Test: A field procedure used to determine in situ permeability, the ability of a formation to produce or accept water, or the ability of a formation to accept grout at a given pressure. (See **Hydraulic Conductivity Test, Lugeon**.)

Q

No grouting terms starting with the letter Q are defined in this Glossary.

R

Reactant: A material that reacts chemically with the base component of a grout system. Usually the minor component.

Reactive Aggregate: An aggregate containing siliceous material (usually in an amorphous or cryptocrystalline state) which will react chemically with free alkali in portland cement. Usually results in expansion of the hardened material, frequently to a damaging extent.

Refusal: A rate of grout take that is low or zero at the maximum allowable injection pressure for the grout hole or grout injection stage. (The "maximum allowable injection pressure" commonly is based on some "rule of thumb" that takes into account the depth of the top of the grouting stage beneath the surface or the shortest distance from that stage to a free face. Optimally, it will be based on the results of extensive pressure tests during a test grouting program, or upon the strength of the rock mass as otherwise determined, and is the pressure which exceeded may cause hydrofracture or ground surface displacement.)

Resin: A material that usually constitutes the base of an organic grout system.

Resin Grout: A grout system composed of essentially resinous materials such as epoxies, polyester, and urethanes. (In Europe, refers to any chemical grout system regardless of chemical origin.)

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.

Rotary Drilling: A drilling process in which a hole is advanced by rotation of a drill bit under constant pressure without impact.

Running Ground: In tunneling, a granular material that tends to move or "run" into the excavations.

Sand: Specifically, soil particles with a grain size ranging from 0.053 to 2.0 mm. Loosely, the aggregate component of grout; in aggregate industry usage may include particles finer than 0.053 mm and particles as large as 9.5 mm.

Sand Equivalent: A measure of the amount of silt or clay contamination in fine aggregate as determined by test (ASTM 2419).

Sanded Grout: Grout in which sand is incorporated into the mixture.

Seepage: The flow of small quantities of water through soil, rock, or concrete.

Segregation: Separation or settlement of the components of mixed grout, either in the agitator or in the grouted opening(s), resulting in nonuniform distribution of grout in the grouted mass.

Set: 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.

Set Time: A term defining: (1) the hardening time of portland cement as measured in the laboratory by a Vicat or Gilmore Needle, or (2) the gel time for a chemical grout.

Shelf Life: Maximum time interval during which a material may be stored and remain in a usable condition. Usually related to storage conditions.

Shrinkage Compensating: Characteristic of grout made using an expansive cement or an admixture that causes a volume increase. If restrained, induces expansive stresses that are intended to offset the tendency of drying shrinkage to induce tensile stresses.

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.

Silt: Soil particles with grains in the size range of 5–53 microns.

Slabjacking: Injection of grout under a concrete slab in order to level and/or raise it to a specified grade.

Slaking: Deterioration of rock on exposure to air or water.

Sleeve Port Grout Pipe (SPGP): Plastic or steel pipe (usually 2.5–5 cm i.d.) with small holes (3.2–9.5 mm) drilled through the wall at given intervals (0.3–1.2 m) with an expandable exterior sleeve covering, forming a one way valve to introduce cement and/or chemical grouts one or more times by use of an internal straddle packer. Installed in a predrilled borehole with the annulus subsequently sealed with a low strength brittle grout for soil permeation or fracture grouting. Or in rock by means of external expandable sleeves placed and inflated at desired intervals. (French term Tube A Manchette.)

Slump: A measure of the consistency of freshly mixed concrete, compaction grout, or low mobility grout (LMG). See **Slump Test**.

Slump Test: The procedure for measuring slump, ASTM C 143 being the most common.

Slurry Grout: A fluid suspension of cementitious materials, sometimes together with noncementitious materials, in water.

Slurry Trench: A trench that is kept filled with a bentonite slurry or other stabilizing agent during the excavation process to stabilize the walls of the trench. Sometimes constructed in conjunction with a grouted cutoff.

Slush Grouting: Application of cement slurry to surface rock

as a means of filling cracks and surface irregularities or by "brooming" to prevent slaking.

Sodium Silicate: A material manufactured by fusing Na_2CO_3 and specially selected silica sands at high temperatures. The resulting product is an amorphous glass which can be dissolved by a special process to produce hydrated sodium silicate in a variety of forms. Used as a base for certain chemical grouts and as an accelerator for portland cement-based grouts.

Soil Cement: Near-homogeneous mixture of cement or a cementitious grout with soil—may be mixed in situ.

Soil-Cement Column (also referred to as Soil-Cement Element): A column of soil-cement formed vertically by injection of cement grout and the controlled mixing and blending with in situ soils that result in a near homogenous mixture of cement grout and the in situ soils. The soil-cement column may be either one round element or be composed of a series of one or more overlapping and interconnected columns installed by the same insertion and withdrawal operation of the mixing tools.

Soil Cement Return: All materials (spoils) including but not limited to, liquids, semisolids, and solids that are discharged above the ground surface during the in situ soil cement mixing process.

Soil Fracture Grouting: The locally confined and (hypothetically and under ideal circumstances) controlled fracturing of a soil unit, (optimally) without significant effect to the soil structure, using a fluid grout. Also, the deliberate uncontrolled fracturing of alluvial deposits by successive injections of grout under high pressure in order to facilitate filling of voids in strata not directly penetrated by the grout hole. Used either for soil improvement (reduce settlements or reduce potential for liquefaction) and/or intentional displacement of the ground (compensation of soil loss during tunneling to reduce settlements). Usually the injection of cementitious slurry grouts of various consistencies ideally through preplaced "sleeve port grout pipes" at pressures exceeding surrounding confining stresses to intentionally fracture the ground. Usually performed in repeated injections through the "sleeve port grout pipe" in small quantities to control/limit grout travel. Requires continual movement monitoring during the injection/fracture process. (Also hydrofracture, hydrosplitting, hydrojacking, and by the French term "claquage.") These techniques are used to increase the bearing capacity and shear resistance of soils as well as compensation grouting in response to settlement, and, sometimes, to reduce the permeability of the soil mass. Ground improvement by soil fracture grouting is based on three mechanisms:

1. The soil unit, or skeleton, was reinforced by a series of hard grout lenses which propagate out from the injection point to form a matrix of hard grout and soil;
2. The fluid grout finds and fills voids and causes some compaction in more coarse-grained soil along the grout lenses created; and
3. The plasticity index of saturated clays decreases through the exchange of calcium ions originating from cement or other fillers.

Soil Mixing: A soil improvement technique used to construct load bearing columns, cutoff walls or retaining walls, and to treat soils in situ. The stabilized soil columns are formed by a mixing shaft rotated by a drill mounted on a crane. As the mixing shaft is advanced into the soil, grout is pumped through the hollow stem of the shaft and injected into the soil at the tip. The auger flights and mixing blades on the shaft blend the soil with the grout in pugmill fashion. The mixing shaft produces individual columns which can be overlapped to form a wall. When the design depth is

reached, the auger is withdrawn and the mixing process is repeated on the way to the surface. Left behind is a stabilized soil-concrete column having the following property/properties: low permeability, improved bearing capacity or shear strength, immobilized contaminants, and when reinforced, the ability to withstand differential soil and hydrostatic loading.

Solution Cavity: Opening in bedrock, commonly developed along open joint or bedding planes or the juncture of two such planes, by dissolution and removal of soluble rocks such as limestone, gypsum, and phosphate rock by moving water.

Sounding Well: A hole, usually cased with slotted casing, which is used to measure the groundwater level. Also, a vertical conduit in a mass of coarse aggregate for preplaced aggregate concrete, which contains closely spaced openings to permit entrance of grout; the grout level is determined by means of a measuring line on a float within the sounding well.

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 one or more specified criteria—such as a reduced grout acceptance, maximum allowable grout pressure, increased resistance or blow count, or a reduction in grout take to a specified value—are achieved.

Stable Grout: A suspension grout that exhibits little or no settlement, bleed, or shrinkage. Historically defined as a grouting mix with a bleed less than 5% in 2 h. However, lesser percentages of bleed—hence enhanced stability—are readily achievable with contemporary multicomponent grout formulations.

Stage: A segment of hole grouted at one time. See **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 drilled to the final planned depth and grouted in ascending stages using packers, or may be incrementally drilled in downward stages and be grouted from the collar of the hole or with packers set in a previously grouted stage.

Stator: Within a progressive cavity pump, the stationary tubular part in which another part (rotor) rotates.

Straddle Packer: A device made up of a grout injection tube combined with two expandable or cup seal packers, allowing the injected grout to pass out into the zone between the two packers and flow into the surrounding soil or rock (also called double packer).

Surfactant: A substance capable of lowering the surface tension of liquids, facilitating the wetting of solid surfaces and facilitating the penetration of liquids into capillaries.

Suspension: A mixture of solid particles suspended in a liquid.

Suspension Agent: An additive that decreases the settlement rate of particles in liquid.

Syneresis: The exudation of water from a newly set neat sodium silica-based or other gel grout over time. Generally greater in gels with a low silica content than in gels with a higher silica content, or with some types of an inorganic (salt) reactants.

T

Take: See **Grout Take**.

Toxic: In the context of grouting: chemical and/or cementitious materials that are harmful during handling and mixing or to the environment when improperly proportioned and/or mixed prior to injection into soil or rock.

Tremie: A concrete, mortar, or grout placement procedure in

which the material is injected through a pipe extending to the bottom of a drill hole, water-filled opening, or cavity, gradually raising the pipe as appropriate to avoid either plugging or mixing with water during the injection process.

True Solution: A solution that is free of suspended matter, i.e., in which the components are 100% dissolved in the base solvent. A Newtonian fluid.

Tube A Manchette: A grout pipe perforated with rings of small holes, typically at intervals of about 12 in. (305 mm) to 40 in. (1,000 mm). 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. Also called a **Sleeve Port Grout Pipe**.

U

Undersealing: A grouting procedure for filling voids that result from pumping at transverse and longitudinal joints or cracks in concrete pavement. Neat cement grout or cement fly ash grout is injected through holes drilled at each joint or crack.

Unstable Grout: A cementitious grout that exhibits excessive water bleed, separation, or segregation.

Uplift: Vertical displacement of a formation due to injection of grout in such a volume and at such a rate and pressure that hydraulic jacking occurs.

V

Vent Hole: A hole drilled to allow the escape of air, water, diluted grout, and/or natural gas. Sometimes used to monitor the flow of grout.

Vent Pipe: A small-diameter pipe, such as may be inserted in a foundation opening or tunnel lining, used to permit escape of air, water, or diluted grout.

Viscosity: The internal fluid resistance of a substance, such as grout, which makes it resist a tendency to flow.

Void Ratio: The ratio of the volume of voids divided by the volume of solids in a given volume of soil or rock.

W

Water:Cement (w:c) Ratio: The ratio of the amount of water to the amount of cement or cementitious materials in a grout mix. As both weight ratios and volumetric ratios are in common use, one should state which is meant whenever mentioning water:cement ratio.

Water:Cementitious Ratio: The relationship by weight of water to cement plus pozzolan (e.g., silica fume, slag cement, or fly ash) in a cement-based grout.

Wetability: The relative ease of fluid flow across a surface or into a pore system due to surface tension as measured by the contact angle of a drop of fluid on a plane of the particular surface.

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.

Yield: The volume of freshly mixed grout produced from a known quantity of ingredients.

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