

Appendix B Frequently Used Tunneling Terms

ANFO - Ammonium nitrate mixed with fuel oil used as an explosive in rock excavation.

Active reinforcement - Reinforcing element that is pre-stressed or artificially tensioned in the rock mass when installed.

Alluvium - A general term for recent deposits resulting from streams.

Aquiclude - 1. Rock formation that, although porous and capable of absorbing water slowly, does not transmit water fast enough to furnish an appreciable supply for a well or spring. 2. An impermeable rock formation that may contain water but is incapable of transmitting significant water quantities. Usually functions as an upper or lower boundary of an aquifer.

Aquifer - 1. A water-bearing layer of permeable rock or soil. 2. A formation, a group of formations, or a part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Aquitard - A formation that retards but does not prevent water moving to or from an adjacent aquifer. It does not yield water readily to wells or springs, but may store groundwater.

Artesian condition - Groundwater confined under hydrostatic pressure. The water level in an artesian well stands above the top of the artesian water body it taps. If the water level in an artesian well stands above the land surface, the well is a flowing artesian well.

Average lithostatic gradient - An approximation of the increase in lithostatic stress with depth.

Back - The surface of the tunnel excavation above the spring line; also, roof (see, also, crown)

Backfill - Any material used to fill the empty space between a lining system and excavated rock or soil surface.

Bench - A berm or block of rock within the final outline of a tunnel that is left after a top heading has been excavated.

Bit - A star or chisel-pointed tip forged or screwed (detachable) to the end of a drill steel.

Blocking - Wood or metal blocks placed between the excavated surface of a tunnel and the bracing system, e.g., steel sets. Continuous blocking can also be provided by shotcrete.

Bootleg or Socket - That portion or remainder of a shot-hole found in a face after a blast has been fired.

Brattice (brattishing) - A partition formed of planks or cloth in a shaft or gallery for controlling ventilation.

Breast boarding - Partial or complete braced supports across the tunnel face that hold soft ground during tunnel driving.

Bulkhead - A partition built in an underground structure or structural lining to prevent the passage of air, water, or mud.

Burn cut - Cut holes for tunnel blasting that are heavily charged, close together, and parallel. About four cut holes are used that produce a central, cylindrical hole of completely shattered rock. The central or burn cut provides a free face for breaking rock with succeeding blasts.

Cage - A box or enclosed platform used for raising or lowering men or materials in a shaft.

Calcareous - Containing calcium carbonate.

Calcite - A mineral predominantly composed of calcium carbonate, with Moh's hardness 3.

California switch - A portable combination of siding and switches superimposed on the main rail track in a tunnel.

Center core method - A sequence of excavating a tunnel in which the perimeter above the invert is excavated first to permit installation of the initial ground support. One or a series of side and crown drifts may be utilized. The center core is excavated after the initial ground support is installed.

Chemical grout - A combination of chemicals that gel into a semisolid after they are injected into the ground to solidify water-bearing soil and rocks.

Cherry picker - A gantry crane used in large tunnels to pick up muck cars and shift a filled car from a position next to the working face over other cars to the rear of the train.

Cohesion - A measure of the shear strength of a material along a surface with no perpendicular stress applied to that surface.

Conglomerate - A sedimentary rock mass made up of rounded to subangular coarse fragments in a matrix of finer grained material.

Controlled blasting - Use of patterned drilling and optimum amounts of explosives and detonating devices to control blasting damage.

Cover - Perpendicular distance to nearest ground surface from the tunnel.

Crown - The highest part of a tunnel.

Cut-and-cover - A sequence of construction in which a trench is excavated, the tunnel or conduit section is constructed, then covered with backfill.

Cutterhead - The front end of a mechanical excavator, usually a wheel on a tunnel boring machine, that cuts through rock or soft ground.

Delays - Detonators that explode at a suitable fraction of a second after passage of the firing current from the exploder. Delays are used to ensure that each charge will fire into a cavity created by earlier shots in the round.

Disk cutter - A disc-shaped cutter mounted on a cutterhead.

Drag bit - A spade-shaped cutter mounted on a cutterhead.

Drift - An approximately horizontal passageway or portion of a tunnel. In the latter sense, depending on its location in the final tunnel cross section, it may be classified as a "crown drift," "side drift," "bottom drift," etc. A small tunnel driven ahead of the main tunnel.

Drifter - A rock drill mounted on column, bar, or tripod, used for drilling blast holes in a tunnel face, patented by J. G. Leyner, 1897.

Drill-and-blast - A method of mining in which small-diameter holes are drilled into the rock and then loaded with explosives. The blast from the explosives fragments

and breaks the rock from the face so that the rock can be removed. The underground opening is advanced by repeated drilling and blasting.

Drill steel - See steel, drill.

Elastic - Describes a material or a state of material where strain or deformation is recoverable, nominally instantaneously but actually within certain tolerances and within some arbitrary time. Capable of sustaining stress without permanent deformation.

Elastic rock zone - The zone outside the relaxed rock zone where excavation has altered the in situ stress field. Rock in the elastic zone undergoes recoverable elastic deformation.

Erector arm - Swing arm on tunnel boring machine or shield, used for picking up supports and setting them in position.

Extrados - The exterior curved surface of an arch.

Face - The advance end or wall of a tunnel, drift, or other excavation at which work is progressing.

Final ground or rock support - Support placed to provide permanent stability, usually consisting of rock reinforcement, shotcrete, or concrete lining. May also be required to improve fluid flow, ensure water tightness, or improve appearance of tunnel surface.

Finite element method - The representation of a structure as a finite number of two-dimensional and/or three-dimensional components called finite elements.

Firm ground - Stiff sediments or soft sedimentary rock in which the tunnel heading can be advanced without any, or with only minimal, roof support; the permanent lining can be constructed before the ground begins to move or ravel.

Forepole - A pointed board or steel rod driven ahead of timber or steel sets for temporary excavation support.

Forepoling - Driving forepoles ahead of the excavation, usually supported on the last steel set or lattice girder erected, and in an array that furnishes temporary overhead protection while installing the next set.

Full-faceheading - Excavation of the whole tunnel face in one operation.

Gouge zone - A layer of fine, wet, clayey material occurring near, in, or at either side of a fault or fault zone.

Grade - Vertical alignment of the underground opening or slope of the vertical alignment.

Granite - A coarse-grained, plutonic (intrusive) igneous rock with a general composition of quartz (10-30 percent), feldspar (50-80 percent), mostly potassium feldspar, and mafic minerals such as biotite (10-20 percent).

Granodiorite - A coarse-grained crystalline, intrusive rock with a general composition of quartz (10-20 percent), feldspar (50-60 percent), mostly sodium-rich feldspar, and mafic minerals such as biotite (20-30 percent).

Ground control - Any technique used to stabilize a disturbed or unstable rock mass.

Ground stabilization - Combined application of ground reinforcement and ground support to prevent failure of the rock mass.

Ground support - Installation of any type of engineering structure around or inside the excavation, such as steel sets, wooden cribs, timbers, concrete blocks, or lining, which will increase its stability. This type of support is external to the rock mass.

Grout - Neat cement slurry or a mix of equal volumes of cement and sand that is poured into joints in masonry or injected into rocks. Also used to designate the process of injecting joint-filling material into rocks. See grouting.

Grouting - 1. Injection of fluid grout through drilled holes, under pressure, to fill seams, fractures, or joints and thus seal off water inflows or consolidate fractured rock ("formation grouting"). 2. Injection of fluid grout into annular space or other voids between tunnel lining and rock mass to achieve contact between the lining and the surrounding rock mass ("skin" or "contact" grouting). 3. Injection of grout in tail/void behind prefabricated, segmental lining ("backfill grouting"). 4. The injection under relatively high pressures of a very stiff, "zero-slump" mortar or chemical grout to displace and compact soils in place ("compaction grouting").

Gunite - See shotcrete.

Heading - The wall of unexcavated rock at the advance end of a tunnel. Also used to designate any small tunnel and a small tunnel driven as a part of a larger tunnel.

Heading and bench - A method of tunneling in which a top heading is excavated first, followed by excavation of the horizontal bench.

Ho-ram - A hydraulically operated hammer, typically attached to an articulating boom, used to break hard rock or concrete.

Hydraulic jacking - Phenomenon that develops when hydraulic pressure within a jacking surface, such as a joint or bedding plane, exceeds the total normal stress acting across the jacking surface. This results in an increase of the aperture of the jacking surface and consequent increased leakage rates, and spreading of the hydraulic pressures. Sometimes referred to as hydraulic fracturing.

Indurated - Said of compact rock or soil, hardened by the action of pressure, cementation, and heat.

Initial ground or rock support - Support required to provide stability of the tunnel opening, installed directly behind the face as the tunnel or shaft excavation progresses, and usually consisting of steel rib or lattice girder sets, shotcrete, rock reinforcement, or a combination of these.

Intrados - The interior curved surface of an arch.

Invert - On a circular tunnel, the invert is approximately the bottom 90 deg of the arc of the tunnel; on a square-bottom tunnel, it is the bottom of the tunnel.

Invert strut - The member of a set that is located in the invert.

Joint - A fracture in a rock along which no discernable movement has occurred.

Jumbo - A movable machine containing working platforms and drills, used for drilling and loading blast holes, scaling the face, or performing other work related to excavation.

Jump set - Steel set or timber support installed between overstressed sets.

Lagging - Wood planking, steel channels, or other structural materials spanning the area between sets.

Lifters - Shot holes drilled near the floor of a tunnel and fired after the burn or wedge cut holes and relief holes.

Line - Horizontal or planar alignment of the underground opening.

Liner Plates - Pressed steel plates installed between the webs of the ribs to make a tight lagging, or bolted together outside the ribs to make a continuous skin.

Lithology - The character of a rock described in terms of its structure, color, mineral composition, grain size, and arrangement of its component parts.

Lithostatic pressure - The vertical pressure at a point in the earth's crust that is equal to the pressure that would be exerted by a column of the overlying rock or soil.

Mine straps - Steel bands on the order of 12 in. wide and several feet long designed to span between rock bolts and provide additional rock mass support.

Mining - The process of digging below the surface of the ground to extract ore or to produce a passageway such as a tunnel.

Mixed face - The situation when the tunnel passes through two (or more) materials of markedly different characteristics and both are exposed simultaneously at the face (e.g., rock and soil, or clay and sand).

Moh's hardness scale - A scale of mineral hardness, ranging from 1 (softest) to 10 (hardest).

Muck - Broken rock or earth excavated from a tunnel or shaft.

Open cut - Any excavation made from the ground surface downward.

Overbreak - The quantity of rock that is actually excavated beyond the perimeter established as the desired tunnel outline.

Overburden - The mantle of earth overlying a designated unit; in this report, refers to soil load overlying the tunnel.

Passive reinforcement - Reinforcing element that is not prestressed or tensioned artificially in the rock, when installed. It is sometimes called rock dowel.

Pattern reinforcement or pattern bolting - The installation of reinforcement elements in a regular pattern over the excavation surface.

Penstock - A pressure pipe that conducts water to a power plant.

Phreatic surface - That surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

Pillar - A column or area of coal or ore left to support the overlying strata or hanging wall in mines.

Pilot drift or tunnel - A drift or tunnel driven to a small part of the dimensions of a large drift or tunnel. It is used to investigate the rock conditions in advance of the main tunnel excavation, or to permit installation of ground support before the principal mass of rock is removed.

Piping - The transport of silt or sand by a stream or water through (as an embankment), around (as a tunnel), or under (as a dam) a structure.

Plastic - Said of a body in which strain produces continuous, permanent deformation without rupture.

Pneumatically applied mortar or concrete - See shotcrete.

Portal - The entrance from the ground surface to a tunnel.

Powder - Any dry explosive.

Prereinforcement - Installation of reinforcement in a rockmass before excavation commences.

Prestressed rock anchor or tendon - Tensioned reinforcing elements, generally of higher capacity than a rock bolt, consisting of a high-strength steel tendon (made up of one or more wires, strands, or bars) fitted with a stressing anchorage at one end and a means permitting force transfer to the grout and rock at the other end.

Principal stress - A stress that is perpendicular to one of three mutually perpendicular planes that intersect at a point on which the shear stress is zero; a stress that is normal to a principal plane of stress. The three principal stresses are identified as least or minimum, intermediate, and greatest or maximum.

Pull - The advance during the firing of each complete round of shot holes in a tunnel.

P-waves - Compressional waves.

Pyramid cut - A method of blasting in tunneling or shaft sinking in which the holes of the central ring (cut holes) outline a pyramid, their toes being closer together than their collars.

Quartz - A mineral composed of silicon and oxygen, with Moh's hardness of 7.

Raise - A shaft excavated upwards (vertical or sloping). It is usually cheaper to raise a shaft than to sink it since the cost of mucking is negligible when the slope of the raise exceeds 40° from the horizontal.

Ravelling Ground - Poorly consolidated or cemented materials that can stand up for several minutes to several hours at a fresh cut, but then start to slough, slake, or scale off.

Recessed rock anchor - A rock anchor placed to reinforce the rock behind the final excavation line after a portion of the tunnel cross section is excavated but prior to excavating to the final line.

Relievers or relief holes - The holes fired after the cut holes and before the lifter holes or rib (crown, perimeter) holes.

Rib - 1. An arched individual frame, usually of steel, used in tunnels to support the excavation. Also used to designate the side of a tunnel. 2. An H- or I-beam steel support for a tunnel excavation (see Set).

Rib holes - Holes drilled at the side of the tunnel of shaft and fired last or next to last, i.e., before or after lifter holes.

Roadheader - A mechanical excavator consisting of a rotating cutterhead mounted on a boom; boom may be mounted on wheels or tracks or in a tunnel boring machine.

Rock bolt - A tensioned reinforcement element consisting of a rod, a mechanical or grouted anchorage, and a plate and nut for tensioning by torquing the nut or for retaining tension applied by direct pull.

Rock dowel - An untensioned reinforcement element consisting of a rod embedded in a grout-filled hole.

Rock mass - In situ rock, composed of various pieces the dimensions of which are limited by discontinuities.

Rock reinforcement - The placement of rock bolts, rock anchors, or tendons at a fairly uniform spacing to consolidate the rock and reinforce the rock's natural tendency to support itself. Also used in conjunction with shotcrete on the rock surface.

Rock reinforcement element - A general term for rock bolts, tendons, and rock anchors.

Rock support - The placement of supports such as wood sets, steel sets, or reinforced concrete linings to provide resistance to inward movement of rock toward the excavation.

Round - A group of holes fired at nearly the same time. The term is also used to denote a cycle of excavation consisting of drilling blast holes, loading, firing, and then mucking.

Scaling - The removal of loose rock adhering to the solid face after a shot has been fired. A long scaling bar is used for this purpose.

Segments - Sections that make up a ring of support or lining; commonly steel or precast concrete.

Set - The complete frame of temporary support, usually of steel or timber, inserted at intervals in a tunnel to support the ground as a heading is excavated (see Rib).

Shaft - An elongated linear excavation, usually vertical, but may be excavated at angles greater than 30 deg from the horizontal.

Shear - A deformation that forms from stresses that displace one part of the rock past the adjacent part along a fracture surface.

Shield - A steel tube shaped to fit the excavation line of a tunnel (usually cylindrical) and used to provide support for the tunnel; provides space within its tail for erecting supports; protects the men excavating and erecting supports; and if breastboards are required, provides supports for them. The outer surface of the shield is called the shield skin.

Shield tail (or skirt) - An extension to the rear of the shield skin that supports soft ground and enables the tunnel primary lining to be erected within its protection.

Shotcrete - Concrete pneumatically projected at high velocity onto a surface; pneumatic method of applying a lining of concrete; this lining provides tunnel support and can serve as the permanent lining.

Shove - The act of advancing a TBM or shield with hydraulic jacks.

Skip - A metal box for carrying rock, moved vertically or along an incline.

Spall - A chip or splinter of rock. Also, to break rock into smaller pieces.

Spiles - Pointed boards or steel rods driven ahead of the excavation, (similar to forepoles).

Spoil - See muck.

Spot reinforcement or spot bolting - The installation of reinforcement elements in localized areas of rock instability or weakness as determined during excavation. Spot reinforcement may be in addition to pattern reinforcement or internal support systems.

Spring line - The point where the curved portion of the roof meets the top of the wall. In a circular tunnel, the spring lines are at opposite ends of the horizontal center line.

Squeezing ground - Material that exerts heavy pressure on the circumference of the tunnel after excavation has passed through that area.

Stand-up-time - The time that elapses between the exposure of rock or soil in a tunnel excavation and the beginning of noticeable movements of the ground.

Starter tunnel - A relatively short tunnel excavated at a portal in which a tunnel boring machine is assembled and mobilized.

Steel, drill - A chisel or star-pointed steel rod used in making a hole in rock for blasting. A steel rod used to transmit thrust or torque from a power source, compressed air or hydraulic, to the drill bit.

Stemming - Material used for filling a blasting hole to confine the charge or explosive. Damp sand, damp sand mixed with clay, or gypsum plaster are examples of materials used for this purpose.

Struts - Compression supports placed between tunnel sets.

TBM - Tunnel boring machine.

Tail void - The annular space between the outside diameter of the shield and the outside of the segmental lining.

Tie rods - Tension members between sets to maintain spacing. These pull the sets against the struts.

Tight - Rock remaining within the minimum excavation lines after completion of a round—that is, material that would make a template fit tight. “Shooting tight” requires closely placed and lightly loaded holes.

Timber sets - The complete frames of temporary timbering inserted at intervals to support the ground as heading is excavated.

Top heading - 1. The upper section of the tunnel. 2. A tunnel excavation method where the complete top half of the tunnel is excavated before the bottom section is started.

Tunnel - An elongated, narrow, essentially linear excavated underground opening with a length greatly exceeding its width or height. Usually horizontal but may be driven at angles up to 30 deg.

Tunnel Boring Machine (TBM) - A machine that excavates a tunnel by drilling out the heading to full size in one operation; sometimes called a mole. The tunnel boring machine is typically propelled forward by jacking off the excavation supports emplaced behind it or by gripping the side of the excavation.

Voussoir - A section of an arch. One of the wedge-shaped pieces of which an arch is composed or assumed to be composed for purposes of analysis.

Walker - One who supervises the work of several gangs.

Water table - The upper limit of the ground saturated with water.

Weathering - Destructive processes, such as the discoloration, softening, crumbling, or pitting of rock surfaces brought about by exposure to the atmosphere and its agents.