



Solutions matrix

The solution to any geotechnical challenge

- Deep foundations
- Earth retention/shoring
- Environmental containment
- Foundation rehabilitation
- Ground improvement
- Groundwater control
- Heave control
- Marine structure support
- Mine stabilization/void filling
- Railroad subgrade stabilization
- Seismic/liquefaction mitigation
- Sinkhole/karst remediation
- Slope stabilization
- Tunneling stabilization
- Underpinning

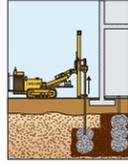
GROUTING



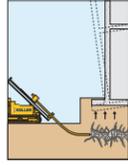
Cement grouting, also known as slurry grouting, is the injection of flowable particulate grouts into cracks, joints, and/or voids in rock or soil.



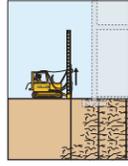
Chemical grouting is the permeation of sands with fluid grouts to increase strength and/or decrease permeability.



Compaction grouting, also known as low-mobility grouting (LMG), is the injection of viscous mortar grout to displace soil and densify granular soil when present. Compaction grouting is also commonly used as a void filling material and to stabilize sinkholes.



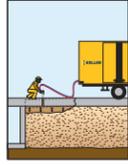
Fracture grouting is the intended discrete hydro-fracturing of soil with slurry grout to produce a controlled heave of soil or a foundation, or to compensate for soil loss during tunneling.



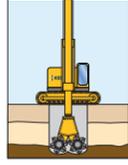
Injection systems is the pressure injection of aqueous solutions into the ground. The composition of the aqueous solution depends on the application, which commonly includes stabilization of expansive soils and railroad subgrades.



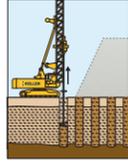
Jet grouting erodes the soil with high-velocity fluids and mixes the eroded soil with grout to create in situ cemented geometries of soilcrete (full or partial columns, panels, or bottom seals).



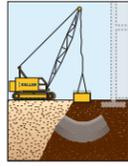
Polyurethane grouting is the injection of polyurethane grouts into concrete joints or cracks for permanent seepage control. HB PolyLift[®] is the injection of lightweight polyurethane foam at shallow depths for concrete leveling and void filling.



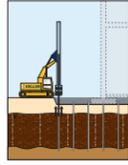
Cutter soil mixing is a wet soil mixing technique that mechanically blends in situ soil with slurry grout in panels to achieve improved engineering properties, such as strength and stiffness.



Dry soil mixing is the in situ mechanical blending of wet soil with dry cementitious materials (binder) to achieve improved engineering properties, such as strength and stiffness.

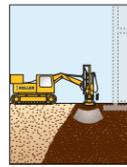


Dynamic compaction is a densification technique used to treat a range of loose or porous soil types by the controlled impact of a crane-hoisted, heavy weight (10-30 tons) on the ground surface in a predetermined grid pattern.

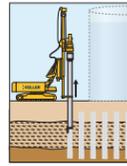


Earthquake drains are high flow capacity, prefabricated vertical drains wrapped with a geo-textile. Earthquake drain programs are designed to limit seismically induced pore pressure buildup to mitigate liquefaction.

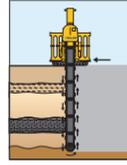
GROUND IMPROVEMENT



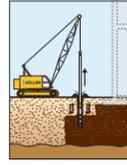
Rapid impact compaction (RIC) applies impact energy to the ground surface which results in densification of loose granular soils and increased bearing capacity and soil stiffness.



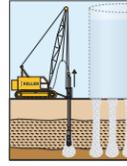
Rigid inclusions are low-mobility grout columns constructed through compressible soils to reduce settlement and increase bearing capacity.



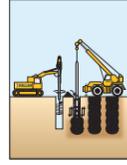
TRD is a wet soil mixing technique that uses a full-depth cutter post to mix in situ soil with cement-based slurry. The result is a mixed-in-place wall with a high degree of homogeneity.



Vibro compaction is the densification of clean, cohesionless soils above and below the water table using a depth vibrator that vibrates in the horizontal direction.



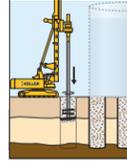
Vibro concrete columns are concrete inclusions constructed with a depth vibrator and attached tremie pipe to reinforce soil and densify adjacent granular soils when present.



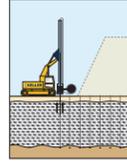
Vibro Piers[®] are vibrator densified aggregate piers that engage the surrounding soil, providing reinforcement and increased shear resistance. The stiff piers increase bearing capacity, reduce settlement, and increase global stability.



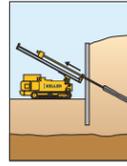
Vibro replacement stone columns are aggregate columns constructed using a depth vibrator to densify the aggregate backfill and surrounding granular soil.



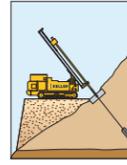
Wet soil mixing is the mechanical blending of in situ soil with slurry grout to achieve improved engineering properties, such as strength and stiffness.



Wick drains consist of a geotextile-filter-wrapped plastic strip with molded channels that allow water to travel to the ground surface. Wick drains are typically installed prior to placement of a temporary fill load to accelerate the consolidation of compressible soils.



Anchors are composed of steel bars or strands grouted into a predrilled hole to resist lateral and uplift forces.

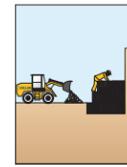


Anchor block slope stabilization consists of discrete, anchored concrete blocks placed in a pattern on a slope to provide stabilization. The anchor force acts on the block, increasing the normal stress within the soil and resistance to shear failure.

GROUND IMPROVEMENT

EARTH RETENTION

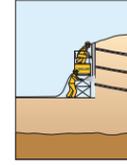
EARTH RETENTION



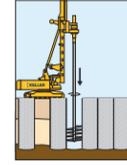
Gabions are rock-filled galvanized steel baskets that are stacked to construct a tiered or sloped gravity retaining wall, or placed to protect channel linings or slopes from erosion.



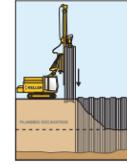
Micropile slide stabilization system (MS³) incorporates an array of drilled and grouted micropiles acting in tension and compression. Micropiles are connected by a reinforced concrete beam creating an integral, stabilized ground reinforcement system.



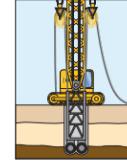
Sculpted shotcrete is an aesthetic covering for vertical cuts reinforced by soil nails or other elements. Shotcrete is sprayed onto the surface and can then be sculpted, stained, and textured in a variety of ways.



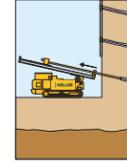
Secant or tangent piles are columns installed adjacent (tangent) or overlapping (secant) each other to form structural walls that resist lateral pressures and groundwater inflow.



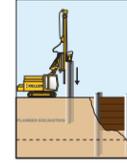
Sheet pile walls are installed by inserting interlocking steel sheets to provide temporary or permanent earth retention systems. Anchors can be incorporated to increase lateral support.



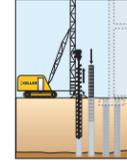
Slurry wall – structural or cutoff construction includes the excavation of a trench through stabilizing slurry designed to support the trench wall. After excavation, the slurry is displaced with purpose-designed low-permeability backfill (cutoff wall) or concrete (structural wall).



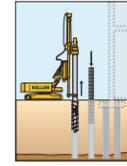
Soil nailing consists of the installation of relatively small, closely spaced inclusions (usually steel bars) to reinforce, stabilize, and retain a soil mass. A surface facing, typically shotcrete or panels, is then applied.



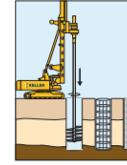
Soldier piles and lagging is a retention system in which vertical piles laterally support lagging that horizontally spans between the piles, providing earth retention. Anchors can be used to increase lateral support capacities.



CFA piles (auger cast) are constructed by rotating a continuous flight hollow stem auger into the soil to a specified depth. Concrete or grout is pumped through the hollow shaft, filling the cylindrical cavity created as the auger is slowly withdrawn.



Displacement CFA piles (displacement auger cast) are constructed by rotating a displacement hollow stem auger into the soil to a specified depth. Concrete or grout is pumped through the hollow shaft, filling the cylindrical cavity created as the displacement tool is slowly withdrawn.



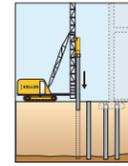
Drilled shafts are reinforced concrete elements cast into drilled holes that transfer heavy loads to a deeper competent soil or rock stratum.

DEEP FOUNDATIONS

DEEP FOUNDATIONS



Driven piles are timber, concrete, or steel deep foundation elements driven vertically to design depth transferring loads through weak soil layers to a suitable bearing layer of soil or rock.



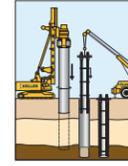
Franki piles, also known as Pressure Injected Footings (PIFs), are high-capacity cast-in-place deep foundation elements constructed using a drop weight casing. This technique has been used to support buildings, tanks, towers, and bridges.



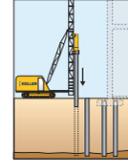
Helical piles are steel piles with discontinuous helical flights that are screwed into the ground to act as compression or tension structural support elements.



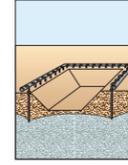
Jacked piers are small diameter pipe piles hydraulically pushed into the soil using the structure as the reaction load.



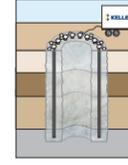
Macropiles[®] are ultra-high-capacity micropiles, with high-strength grout, steel reinforcement, and increased diameter. A macropile is drilled and typically bears on or in rock, but can also bear in very dense soils.



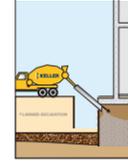
Micropiles are small-diameter, low- to high-capacity structural elements that can provide compressive, tensile, or shear support as foundation or slope stabilization components. Micropiles can be installed in almost any type of ground, and in restricted access or low headroom situations.



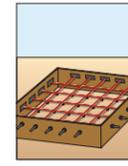
Dewatering involves the installation of predrainage devices (wells, wellpoints, or ejectors) to lower the groundwater table or relieve groundwater pressure so that excavation can be done "in the dry" and under stable ground conditions.



Ground freezing converts in situ pore water to ice through the circulation of a chilled liquid via a system of small diameter pipes placed in drilled holes. The ice acts to fuse the soil or rock particles together, creating a frozen mass of improved compressive strength and impermeability.



Pit underpinning is the strategic excavation of narrow trenches under an existing structure that are filled with concrete for structural support to allow for adjacent excavation.



Post-tensioning creates cast-in-place, prestressed concrete by reinforcing the foundation after concrete has been placed. It's external compressive force makes the concrete more resistant to the tensile stresses that cause a foundation to pull apart and crack. It's used for both slab on grade and elevated floor systems.



Slab jacking is the controlled injection of grout through a concrete slab at strategic locations to relevel the slab.

ADDITIONAL TECHNIQUES

