DST TECHNOLOGIES

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'SNART': Soil Nail and Root Technology
A Technical Overview

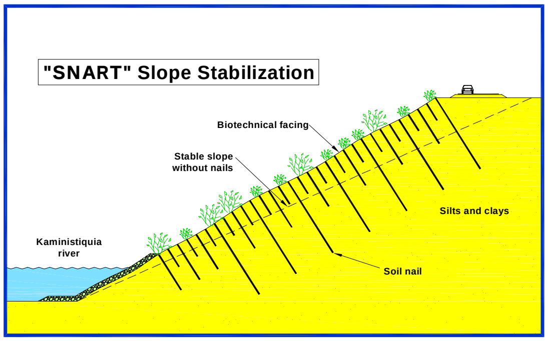
Background

DST is a firm of engineers and contractors established in 1971. As a result of increased pressure from clients to find better options for unstable earth slopes, DST in 1999 developed a system that integrated 3 proven technologies: soil nails, laterally loaded piles and biotechnical stabilization.

The SNART system was specifically developed for slopes that cannot be stabilized by simply flattening them or draining them, whether due to access restrictions or environmental issues. SNART is an economical design-build alternative to retaining walls and mechanically stabilized earth, in fact it has proven in most cases to be *the* lowest cost solution for most unstable slopes up to 45^0.

The SNART Features

- Fast and safe installation using light equipment
- Engineered for site specific soil and groundwater conditions
- A very flexible system - accommodates a wide range of design criteria
- A green solution, leaving no evidence of the system after installation
- Existing vegetation can be preserved
- No excavation or soil disposal required
- No construction impact on nearby roads or railways
- Available as a design-build solution
- Proven performance in sand, silt and clay soils
- Surgically applied only to affected areas.
- Custom designs to fit budget and degree of risk
- A 100 year design life
- Virtually no maintenance
- Very low cost



The SNART Nails

On the basis of many engineering analyses, many installation trials and stabilizing several sites, it was found that slopes typically require 30 to 50 mm (1 to 2 inch) diameter steel nails on a grid spacing of 1 to 2 m (3 to 6 feet). The length of the nails increases with the slope height, level of the water table and the target safety factor. Nails are headed, and typically vary in length from 3 m (10 feet) to as much as 25 m (80 feet). A typical SNART design incorporates 2 to 4 different lengths.

SNART Installation

To make the economics outstanding, a soil nail installation method was developed that eliminated the conventional drilling and grouting. Methods were successfully developed for insertion of the nails through percussion, vibration and rotary methods. Three rapid splice types were also developed for various conditions where the nail length exceeds 5 m (16 feet).

Furthermore, for steeper slopes, installation equipment was developed that could easily access and move around on the slope, basically a spider-like hydraulic machine. This means that there is no construction impact on land use at the crest or the toe of the slope, and eliminates the need for special equipment such as cranes, anchors and platforms to work on the slope. Underground slope movement is monitored during construction with a proprietary sliding pipe underground detector (SPUD).

The SNART Facing

It was found that the traditional very costly concrete facing could be eliminated for slopes flatter than 45 degrees. The solution is a biotechnical facing, consisting of vegetation roots. While this is a well-developed technology, it does not by itself improve the stability of the slope against slides that extend below the roots. A biotechnical facing was, however, found to integrate well with the nails and efficiently address the shallow soil instability between nails, effectively replacing the concrete facing.

The SNART Design

Traditional soil nail design, based on tension capacity, is not readily applied to flatter slopes. SNART nails instead rely on the resistance of the soil as it bears against the side of the nail immediately below and above a potential shear plane. The nail is selected for adequate shear and bending resistance. The nail stiffness will control the length of the available soil resistance along the nail as well as the deformation required to mobilize the resistance.

The slope is analyzed with limit equilibrium methods based on site-specific soil parameters, slope geometry, external loads such as earthquakes and water table level. Where minimal information is available, conservative assumptions can be applied. The design is then based on the desired level of risk (through a target safety factor) using limit equilibrium methods for circular, translational and wedge type failures. A soil resistance function with depth is developed for the nails using FHWA and LPILE methods, which can also be derived from an in-situ bar resistance test (BRT). Adjustments are made for strain softening soils, where required. Resistance data is applied to the stability analyses to find the optimum nail diameter, length and spacing. Finally, checks are made for overstressed zones in the slope and for deformations. The latter are typically less than 20 mm (3/4 inch) near the surface, and much less with depth.

The SNART Nail Head

While vegetation roots have the ability to prevent very shallow slides within the root zone, the nail itself is inadequate for preventing soil movements which flow around the nail within a shallow zone below the roots. An innovative nail head was therefore developed to provide additional resistance and integrate the facing with the nails. This head essentially provides additional resistance at shallow overburden pressures, assisted by developing a degree of soil arching between the heads.

SNART Long Term Performance

The SNART system is permanent. The long term durability of the nails is normally addressed with a sacrificial allowance for corrosion similar to steel piles. For aggressive environments, alternate protection is available. Splices are used that do not compromise the design life. Unlike conventional soil nails where tension capacity is critical and is seriously affected by even minor corrosion pitting, the SNART system is not dependant on tension. A typical design life specified is 50 to 100 years.

SNART Feasibility

SNART is suitable for most soils, having been used successfully for sand, silt and clay soils. However it does not: stop erosion at the toe as a result of waves and currents. Furthermore, it may not be more economical than mechanically stabilized earth where the slope has yet to be constructed. Finally, it cannot be easily applied to slopes steeper than 50 degrees, or soils containing boulders.

Note that for other systems there is little opportunity for design adjustment after installation, this would be too costly. With SNART, on the other hand, it is relatively simple to add additional stability and stiffness, typically with additional nails. Furthermore this can be done surgically, only where necessary.

SNART Benefits

- It ‘permanently’ stabilizes an unstable slope at a cost less than any other system.
- It’s a ‘green’ solution. The system has no impact on the environment.
- It makes the property safe, increasing its value.

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