

## SEA Threaded Hollow Bar Soil Nail

### Introduction

All SEA systems have a comprehensive range of accessories and specifications to meet the most demanding challenges Geotechnical Engineers face.

SEA's engineering expertise allows us to manufacture items specific to our customer's requirements and coupled to our research and development programme, we continually update and improve our products to meet the changing demands of our customers and the industry.

The information below is a general introduction to Soil Nailing, explaining the purpose of the nail, where it can be used, the type of equipment required and guidelines for installation. All soil nailing work varies and is dependent on a number of elements including the ground conditions, access, client specification and design criteria. The following information is for guidance only.

### What does a Soil Nail do?

The purpose of the SEA soil nail is to reinforce the earth by providing friction, shear and tension strengths across all materials to produce a monolithic structure. They are often used in the following circumstances:

- Rock face stabilisation
- Embankment retention / stabilisation
- Piling / Foundation
- Diaphragm wall / Cofferdam strengthening
- Underpinning
- Tunnel wall bolting / pinning

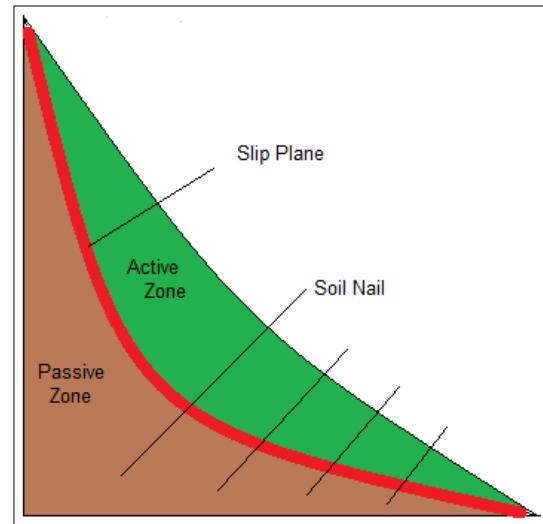
SEA soil nails are installed using rotary percussive equipment and grout is simultaneously pumped down the inside of the hollow bar and out through 'ports' in the SEA drilling head. By grouting as you drill, the grout penetrates into all loose material; filling cracks and

fissures and therefore improving the bond with the ground.

Unlike solid bar, pumping grout under pressure delivers a grout body of approximately twice that of a solid bar.

Soil nails are installed typically in a grid pattern where there is a 'Slip Plane' on a slope between the Active Zone and the Passive Zone. The soil nail penetrates through the Slip Plane and Active Zones and is anchored into the Passive Zone.

No loads are applied to the soil nails until the ground moves which then activates the tension and shear values in the SEA soil nail. This grid pattern when activated creates a monolithic structure able to support the required loads. Depending on the friction of the ground will determine the number of nails and the spacing of them.



### **What size Nail do I need?**

The SEA Soil Nail brochure and detailed on-line information provides key dimensions, technical specification and a guide to design loads for various ground conditions but the following are general rules for the calculation and installation of soil nails.

1. Soil Nails must penetrate into the passive zone by a minimum of 4 to 5 meters.
2. Additional soil nails should be installed at the edge of the area being stabilized and the spacing of the soil nails, both horizontally and vertically must be directly related to the friction value of the soil.
3. After excavation, soil nails should be installed as early as possible to ensure maximum strength is achieved. Delays allow the ground to relax which further destabilizes the area.

## Calculation

Length of Nails	0.5 to 0.7 x wall height but not less than 6.0m
Capacity of nails	50 to 250kN/m <sup>2</sup>
Density of nails	1.5 to 2 per m <sup>2</sup>
Amount of reinforcement	1.5 to 6.0 kg/m <sup>3</sup>
Nail Forces	50 to 100 kN (in special applications up to 300kN)
Inclination of nails	0 to 30 degrees
Deformation of nailed wall	1.5% x wall height

## What equipment is required?

In most cases a rotary percussive rig or mast attachment is required with a cement grout mixer and pump.

The range of rig / attachments required is dependant on the location, access and bar size. There are many rig suppliers including but not limited to, Morath, TEI Rockdrill, Atlas Copco, Ingersol Rand, Marini, Krup, Boart Longyear.

Grout mixer suppliers include but are not limited to Colcrete Eurodrill, Chemgrout, Hany.

## How to Install

Depending on the ground conditions this system can use either 'air' or 'grout / water' as a flushing medium. Air is typically used where there is no danger of the hole collapsing, this is normally found in rock and hard ground. Under normal conditions a mixture of grout and water is pumped during installation and when the required depth is reached, only pure grout is to be pumped. Close attention should be paid to the changing colour emerging from the installed anchor and only when the pure grout emerges should the pump cease.

A weak grout / water cement ratio of up to 50kg of cement to 40 to 70 litres of water should be used at a pump flushing pressure of 5 to 20 bar. Care should be taken when installing in absorbent ground as the grout may tend to set very quickly, so it is advised to increase the water content on the primary installation and apply pure grout at the final stages ensuring pure grout returns to the surface. This will require a ratio of up to 100kg of cement to 40 to 70 litres of water.

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The drill bits have radial flushing holes which will maintain the grout bulb at the drill head, this in turn maintains the column diameter throughout the total shaft length.

Dependant on ground conditions the increase in shaft diameter can be up to 2.5 times. The reason for this is due to the slow increase of pressure (up to 60 bar) as the grout is continuously pumped whilst rotating which reams the soil and causes the grout to penetrate further into the soil structure.

This ream effect is caused partly by cured cement blocking the upward movement of grout and forcing the grout outwards from the rotating bar into the surrounding soil.

**NB** As a general rule approximately two bar pressure is required to lift one meter of grout.

Another advantage of using a percussion hammer for installation is the oscillation action acts like a vibrator during the drilling and final grouting process and the consequent results is a homogeneous and compacted grout body.

### **Installation tips**

If the ground has little or no clays or peats and is predominantly rock, then flushing can be done with air, water or a weak grout / water mix to save excessive grout being lost and increased cost. The positions of the flushing holes in the SEA bits allows for a degree of pressure or 'crowd' to be applied whilst drilling to increase installation speeds. Care needs to be taken to ensure the visible flush at the surface doesn't stop which would indicate excessive 'crowd'. Too little 'crowd' and the water or grout mix will overflow. The picture below indicates the correct flow of grout when flushing.



## Drill bit selection?

### Star Cut



Normally, this is the first choice if there are no hard rock bands. A very cost effective bit giving high installation rates. This bit cuts with a shear action to slice and mix the material being cut. Unlike other bits, the flushing holes are positioned behind the cutting blade to move material quickly away from the drill head. The hardened blades enable the bit to cut through tough Clays, Sand and weak Rock bands.

### Tri Spiral

Multi purpose drill bit with hardened spiral blades, which aid fast entry, and high installation rates, ideal for land fill, sandy soil with very weak marl and mudstone.



### Rock Breaker



Designed for drilling Sandstones, Chalk and very hard dry Clays where you need a shearing action to slice through materials, it can also cut through weak rock bands and with care will cut cast concrete with re-bar obstructions.

### Tungsten Thor

The Thor bit is the workhorse of bits and can deal with hard rock and gives you the opportunity to flush with water and in some cases air. This bit can cope with most materials and offers good installation rates.



### Mole



This displacement bit can help prevent the expensive removal of waste material from projects such as highway development, tunnels and toxic sites. The square design reduces skin friction to enable faster installation (up to 8 metres per minute in soft ground), saving time and money. As no flushing is required, further savings are made on reduced grout quantities.

### **Advantages of the SEA Soil Nail System**

- SEA soil nails can be installed using smaller rigs which can cope with any slope angle and confined spaces.
- There is no requirement for case lining the hole; reducing cost and inconvenience.
- There is little vibration on installation, keeping disturbance to a minimum.
- Typically less expensive than anchored retaining walls.
- Have the highest yield to weight ratio in the market.
- Have increased hole diameters for increased flushing and grouting.
- Do not 'jam' in the drive, making it easier to unscrew and add couplers and lengths.
- Have a variety of drill bits for all ground conditions.