EARTH ANCHORING SYSTEMS FOR INFRASTRUCTURE APPLICATIONS

ANDY CONSTANTINE – CIVIL SALES MANAGER

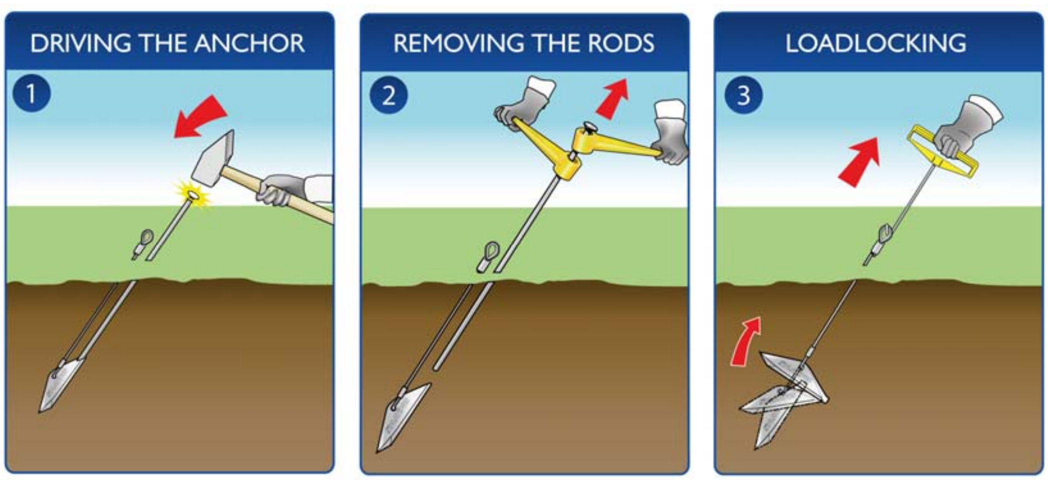
THE CONCEPT

The Percussion Driven Earth Anchor (PDEA®) was originally developed in 1983 as a unique, modern and versatile device that could be rapidly deployed in most displaceable ground conditions.

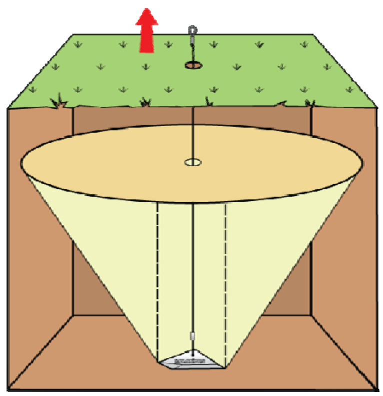
The original design provided a lightweight, corrosion resistant anchor that did not disturb the soil during installation. It could be driven from ground level using conventional portable equipment, could be pulled to an exact holding capacity and be fully operational immediately.

HOW A PERCUSSION DRIVEN EARTH ANCHOR (PDEA®) WORKS

INSTALLING THE ANCHOR



FRUSTUM CONE



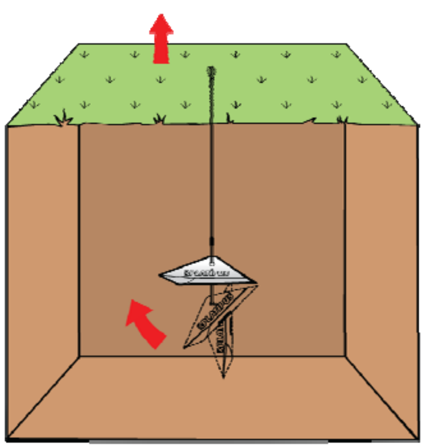
Due to the shape of the anchor and the offset attachment point of the wire tendon, when a load is applied, the anchor will rotate in the ground by up to 90° and loadlock.

As the load exerted on the soil by the anchor system increases, a body of soil above the anchor is compressed and provides resistance to any further anchor movement. The size and spread of this body of soil can be visualized as being a truncated cone or frustum. We refer to this soil as the Frustum Cone.

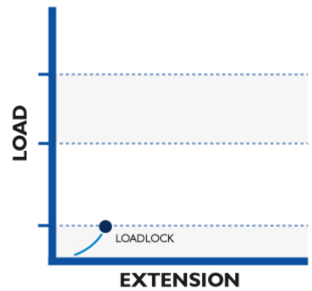
The size and spread of a Frustum Cone will depend on:

- The shear angle of the soil
- The size of the anchor
- The depth of installation
- The load applied

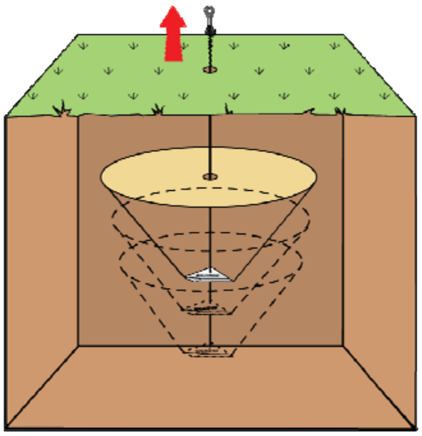
LOADLOCK



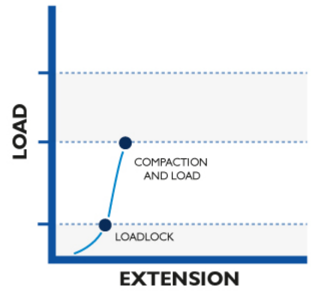
The first stage of the graph is where a load is applied to move the anchor into its loadlocked position. Elements of both load and extension are present.



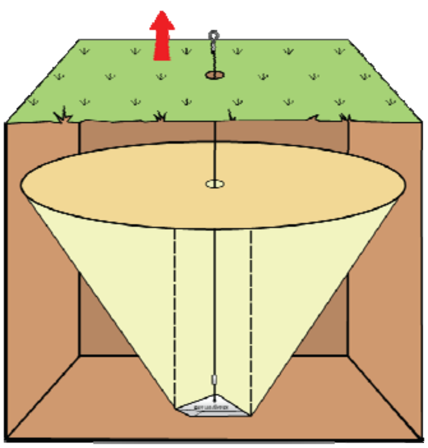
COMPACTION AND LOAD



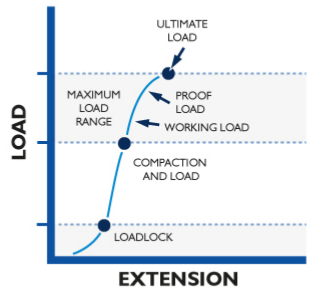
The second stage of the graph is where the anchor system is generating its frustum cone. At this stage, load normally increases with minimum extension. The nature of the material in which the anchor is placed will affect the potential extension.



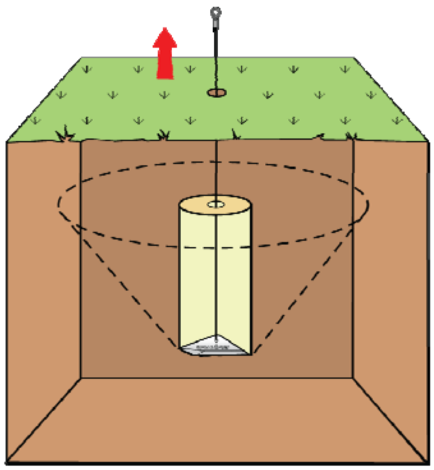
MAXIMUM LOAD RANGE



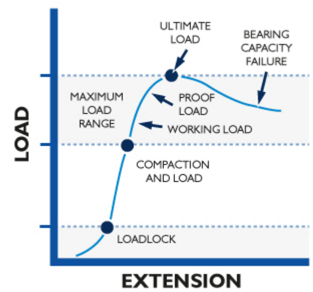
This is the section between working load and ultimate load. As the anchor load approaches the bearing capacity of the soil, the rate of increase in load will reduce until bearing capacity of the soil takes place.



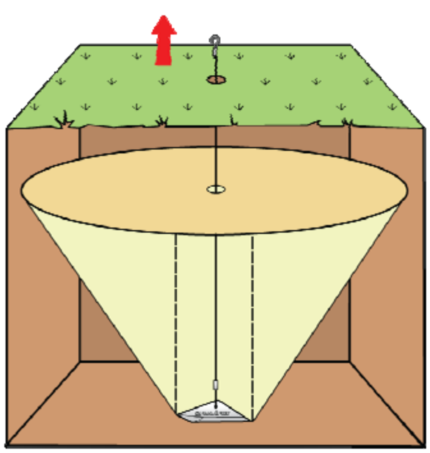
BEARING CAPACITY FAILURE



When the mechanical shear strength of the soil has been exceded, the residual load will decrease with continued extension as the anchor shears through the ground.

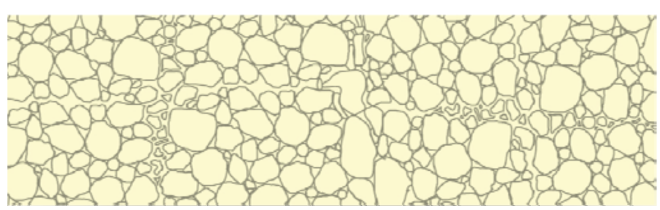


NON-COHESIVE SOIL

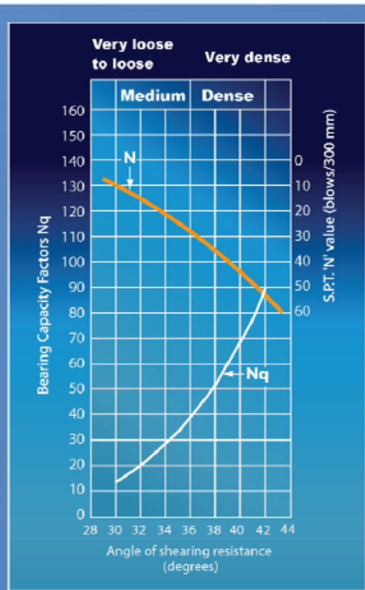


A typical non-cohesive soil consists of particles which interlock, bond and compact when subjected to a load. Coarser sands (ranging from 0.6mm – 2mm) and gravels (coarser than 2mm) are generally of this composition.

Our anchor systems perform exceptionally well in free draining non-cohesive granular soils, displaying shorter loadlock and extension characteristics, larger frustum cones and higher loads.



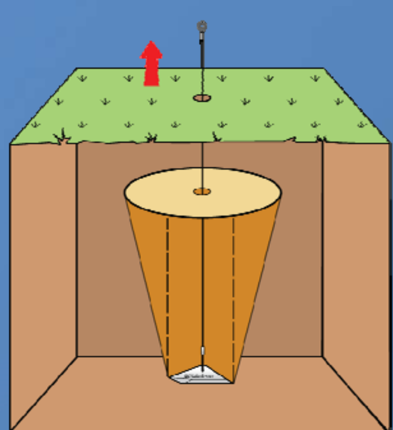
PECK HANSON & THORNBURN



Ultimate Bearing Capacity of Mechanical Anchor = Effective overburden pressure x Bearing Capacity Coefficient x Shape Factor x Projected Area of anchor plate

qf = p0 x Nq x S x A

COHESIVE SOIL



In a typical cohesive soil, the mineral particles are of ‘plate-like’ form. The space between each of the ‘plates’ contains water which dissipates when subjected to load. Gravelly or Sandy silts and clays with particles finer tan 0.002mm are generally of this composition.

Cohesive soil represents the weakest material to anchor into and generates the smallest frustum cone and lowest loads.

ANCHOR CAPACITY

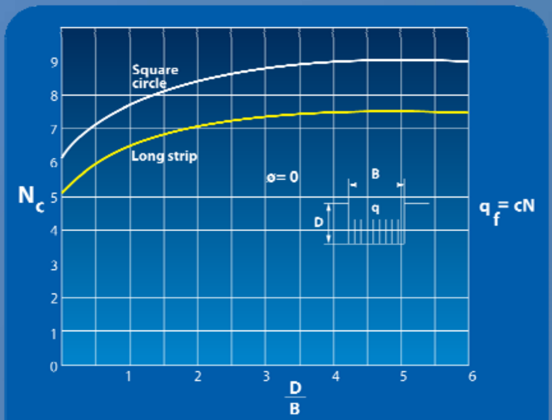
The ultimate bearing capacity achieved by a mechanical anchor, in a purely cohesive soil, is governed by:

a) The loading history, moisture content and soil structure at the deployed anchor position and in the area of increased pressure immediately in front of it, represented by a term known as undrained shear strength.

b) The size and shape of the anchor plate.

1951 ALEC SKEMPTON

Widely accepted formulae allowing the quantification of the ultimate bearing capacity of clay foundations.



Skempton's Bearing Capacity Coefficients (1951)

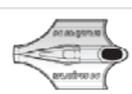
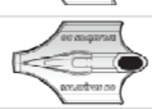
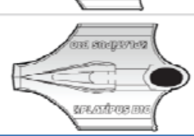
Ultimate Bearing Capacity

=

Undrained Shear Strength x Skempton Bearing Capacity Coefficient NC x Shape Factor

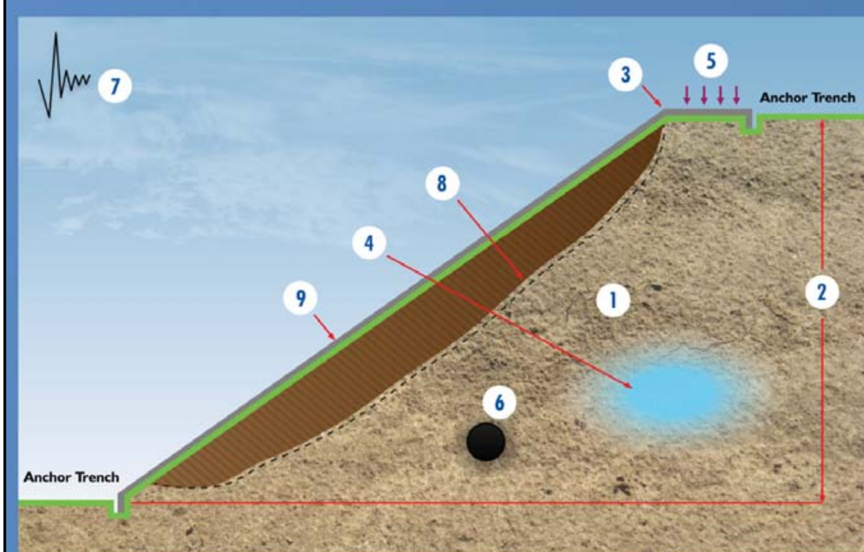
ANCHOR PLANS

Product Code	E=Eye Version	Plan Area (mm², inches²)	
S2		930	2.32
S4		4,127	6.39
S6		8,200	12.71
S8		19,555	30.31

Product Code	T=T-Loc Version	Plan Area (mm², inches²)	
B4		28,736	44.5
B6		45,500	70.5
B8		71,500	110.8
B10		115,800	179.5

SHALLOW PLANE FAILURES

DESIGN CONSIDERATIONS



1. What is the soil type / conditions where the anchor will reside?
2. What is the vertical height of the embankment?
3. What is the slope angle?
4. Is there pore water pressure within the embankment?
5. Is there a surcharge affecting the stability of the slope?
6. Are there any buried services which may obstruct the anchor?
7. Is the site within a seismically sensitive area?
8. How deep is the critical failure plane?
9. Using a standard geotechnical embankment stabilization program, how much load needs to be applied to the surface to stabilize the slope?
10. What is the factor of safety? (usually between 1.2-1.5)?
11. What is the design life?

WINSTON SALEM STATE UNIVERSITY

The Challenge:

- A railroad line separates a new remote parking lot from the main campus at WSSU.
- Construction of a bridge required to connect the lot to campus
- Slope analysis software reveals one of the bridge abutments to be unstable during seismic activity
- Soils: Sandy silt with little to no cohesion. Partially weathered rock.
- Global stability analysis modelled a failure plane at approximately 8’

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The Solution:

- Anchored Reinforced Grid Solution (ARGS®) with a Platipus 2 TN assembly
- Surface Protection: Steel mesh reinforced grid with a 4” concrete face
- Anchor to be pre-tensioned prior to concrete placement
- Load plate and wedge grip post tensioned against the concrete once cured

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- Winston Salem State University
- Norfolk Southern Corporation
- Summit Design & Engineering
  - Harold D. Pruitt, P.E, Sr. Geotech
- New Atlantic – Project Managers / GC
- Smith-Row, LLC Bridge Builder
- Platipus Earth Anchors - USA

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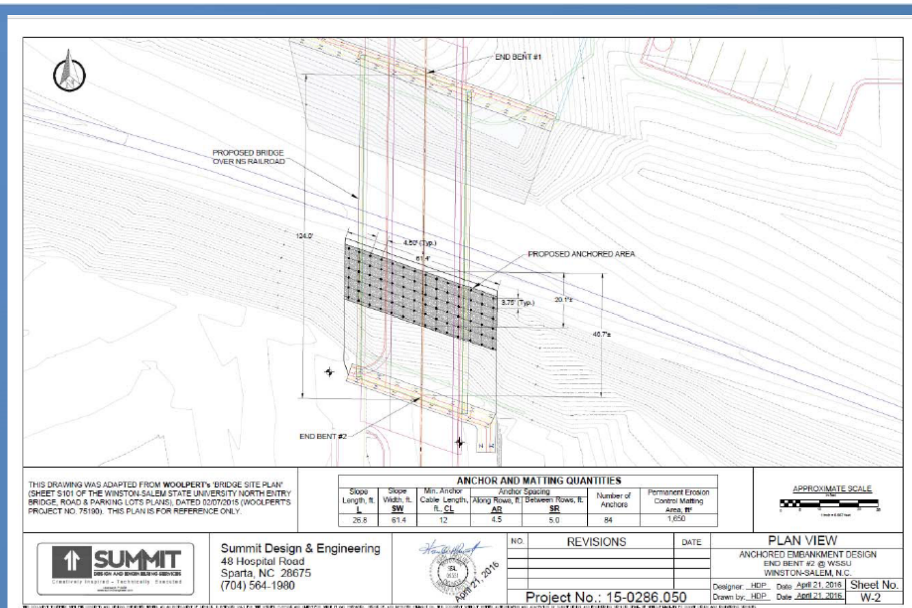

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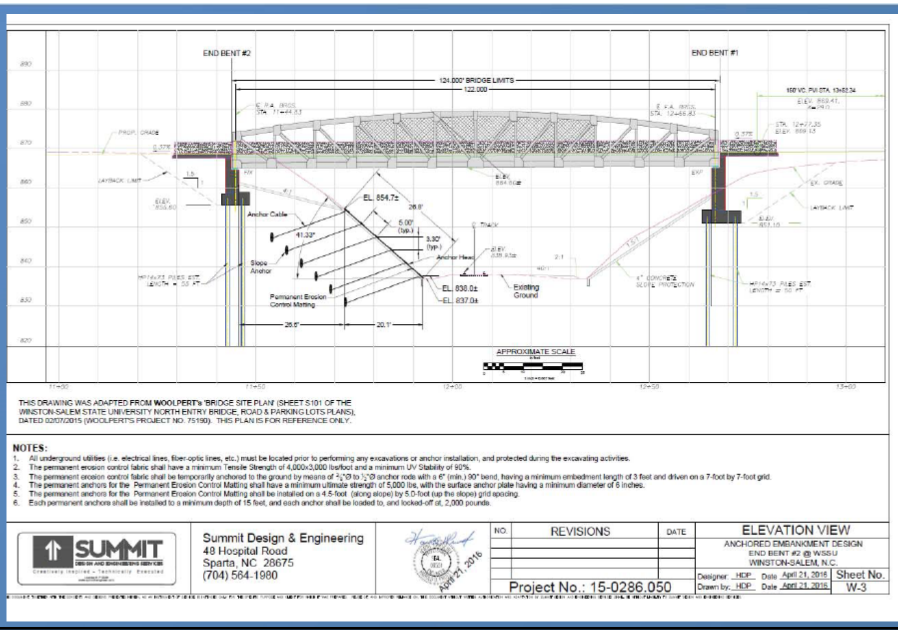

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Any Questions?