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Deep Soil Injection Using Polyurethane Foam

THEORIES AND METHODS

Patrick Burchett
Technical Manager / NCFI Geotechnical

- With NCFI Polyurethanes for over 23 Years
- Worked as NCFI Territory Manager SPF Insulation and SPF Roofing and Coatings. Including numerous other Specialty SPF systems
- Instrumental in forming the Geotechnical Division of NCFI Polyurethanes 2008
- Active Participant in the Colorado School of Mines Grouting Course
- Graduate of the Colorado School of Mines Grouting Course 2007
- SPFA Geotechnical Committee Member
- Active Participant in the Ground Improvement and Grouting Geotechnics (GIGGs) Consortium at the University of Texas at Austin

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Deep Soil Injection

- Used to densify soils at depth
- Increases opportunity for packing and confinement of polyurethane to increase density and compressive strength

Deep Soil Injection

- More complex and costly
- Requires significantly more detail about the soil density and voids
- Estimating is more detailed
  - Labor
  - Equipment
  - Drilling
  - Pounds Per Injection
- Recommend Engineering

Selecting a Polyurethane Foam

Density

- ***Higher*** densities for greater load bearing capacity
- ***Lower*** Densities for lower weight and general void filling

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Selecting a Polyurethane Foam

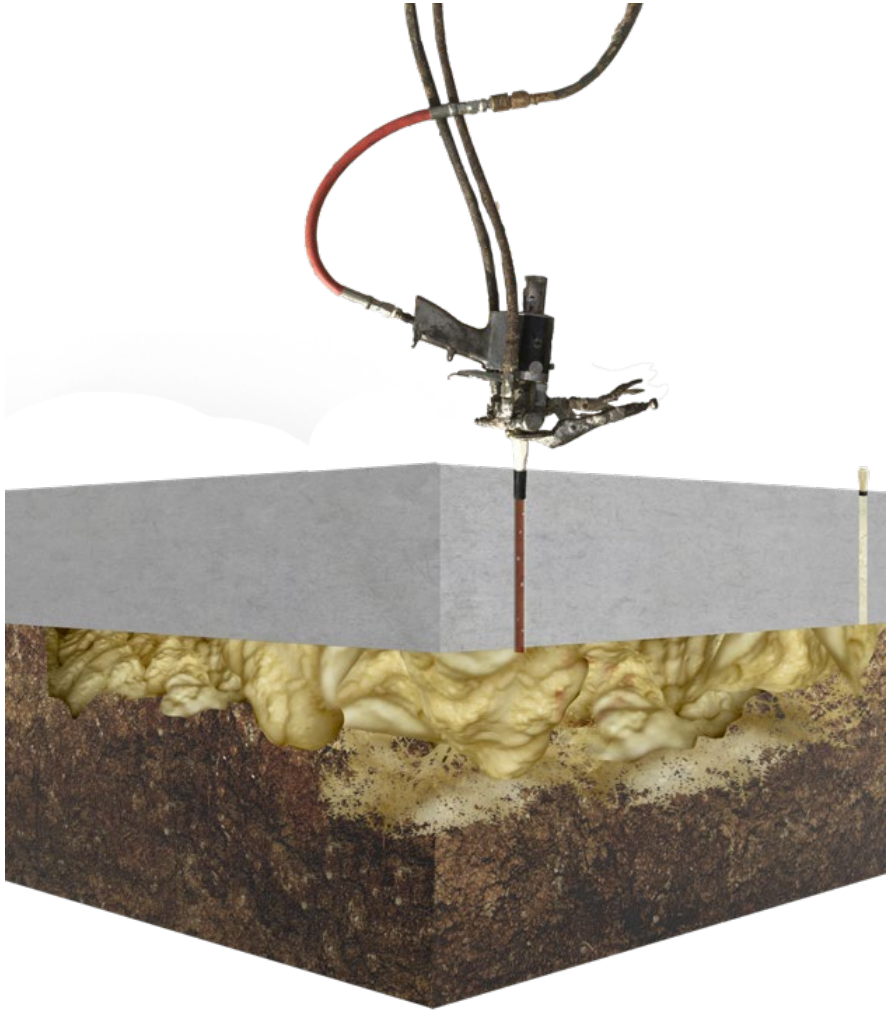
Reactivity

- **Fast** reactivity for Pinpoint lifting and control
- Strong physical properties
- **Less coverage** under slab per injection location

Selecting a Polyurethane Foam

Reactivity

- ***Slow*** **or Longer reactivity times to optimize spread and void fill**
- ***Even*****, Gradual Expansion**
- ***More Coverage/Spread/Permeation*** **per Injection Location**



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Deep Soil Injection

3ft - 5ft Horizontal And Vertical Grid Pattern

Deep Soil Injection

Injections are Top Down, to create as much load pressure on the lower layers to increase density and compressive strength

Deep Soil Injection

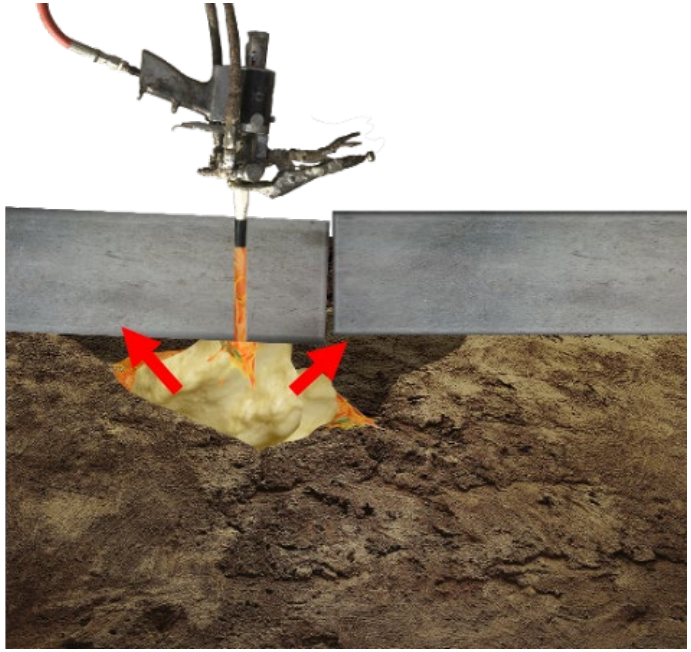
- The below soils are now denser and more compacted
- The polyurethane on the next injection level will now pack and break confinement faster

Deep Soil Injection vs. Slab Lifting

Defining some terms:

Slab Lifting – Injection directly under the slab (on top of the soil) for the purpose of raising the concrete

Deep Soil Injection – Injection directly into the soil at prescribed depths below the slab to stabilize soils and lift



Deep Soil Injection vs. Slab Lifting

Common Misconception:

Slab Lifting by itself will improve or stabilize soils in a meaningful way

While under certain circumstances Slab Lifting may yield slight improvement in the bearing capacity of the upper few inches of loose or saturated soils, on the whole true soil improvement must go deeper

Deep Soil Injection vs. Slab Lifting

The Path of Least Resistance:

During injection, the foam will spread out as far as it can, given the environmental conditions and polyurethane system in use. Confinement will eventually force the foam to exert most pressure vertically, and only then begin to lift

Lifting with either method requires that the foam overcome the force applied to it by the slab/structure overhead

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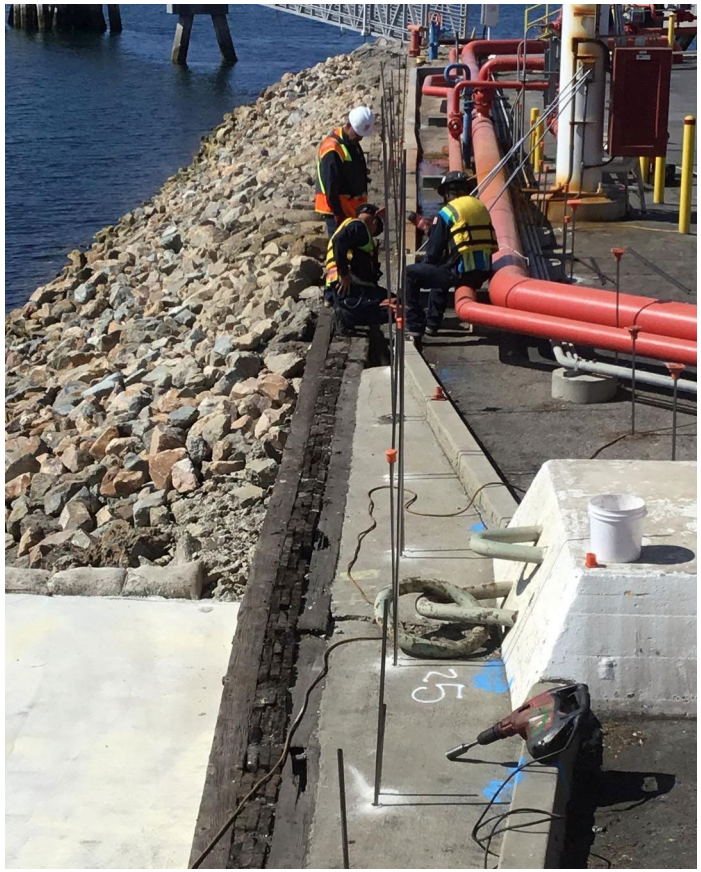
Deep Soil Injection vs. Slab Lifting

The Path of Least Resistance:

When Slab Lifting, the concrete will lift before high levels of confinement pressure are reached.

Deep Soil Injection allows for greater confinement, tighter packing of the foam, and thus higher pressures exerted on the surrounding soils, leading to soil densification.



Deep Soil Injection Probe Rods

Probe Rods – probes can be made of any rigid metal pipe; typically, copper or steel

Some probes are made using PEX pipe and driven using a solid rod inside

Recommended 1/2” O.D. (3/8” I.D.) steel tubing

PVC or conduit is not recommended

Deep Soil Injection Probe Rods

Tube Tap or Packer

Dandy Top

Points or Tips

Deep Soil Injection Probe Rods

Tips serve the primary purpose of keeping dirt out of the end of the probe rod when driving into the soil

Dandy Tops are available in both threaded and compression style.

A standard plastic packer works well with PEX pipe

Project Viability

Projects are always unique in their cause, extent of damage or remediation and approach

There are many steps in determining the correct solution. The most important of these is gathering information about the project.

Involve the right people to help determine project scope and develop a plan to address all repair needs and cause.

Project Viability

Determining whether you will take on a project not only involves gathering project information.

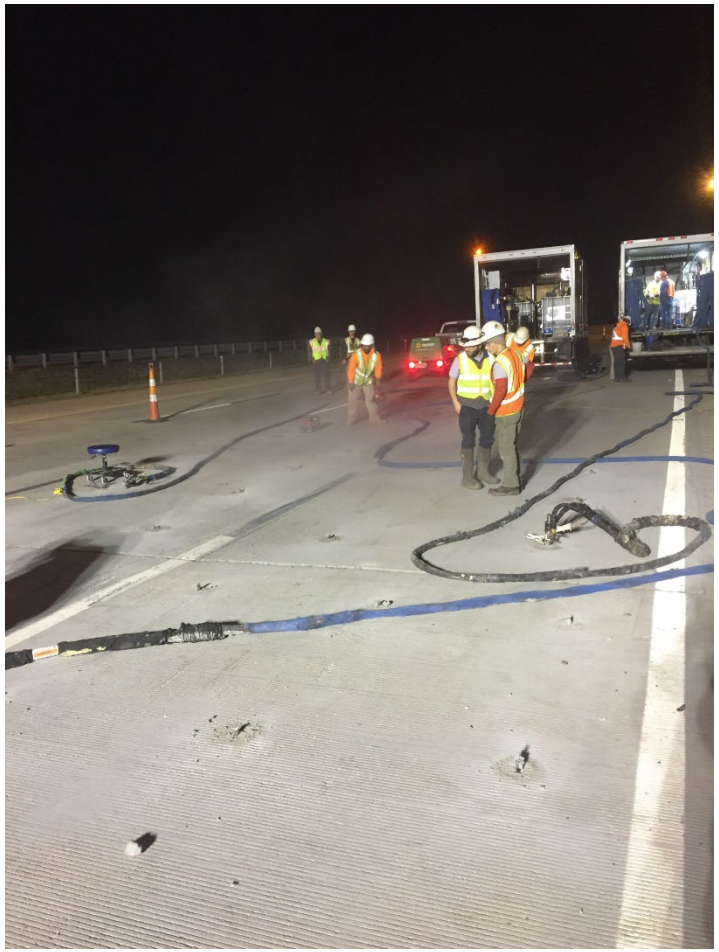
DI projects can be expensive. Make sure your potential customer can afford it. Ensure you have contracts with appropriate language signed and in place prior to commencing work.

120 locations X 15 lbs. X $16 per lb. = $28,000

Project Viability

Ensure your equipment can handle the job.

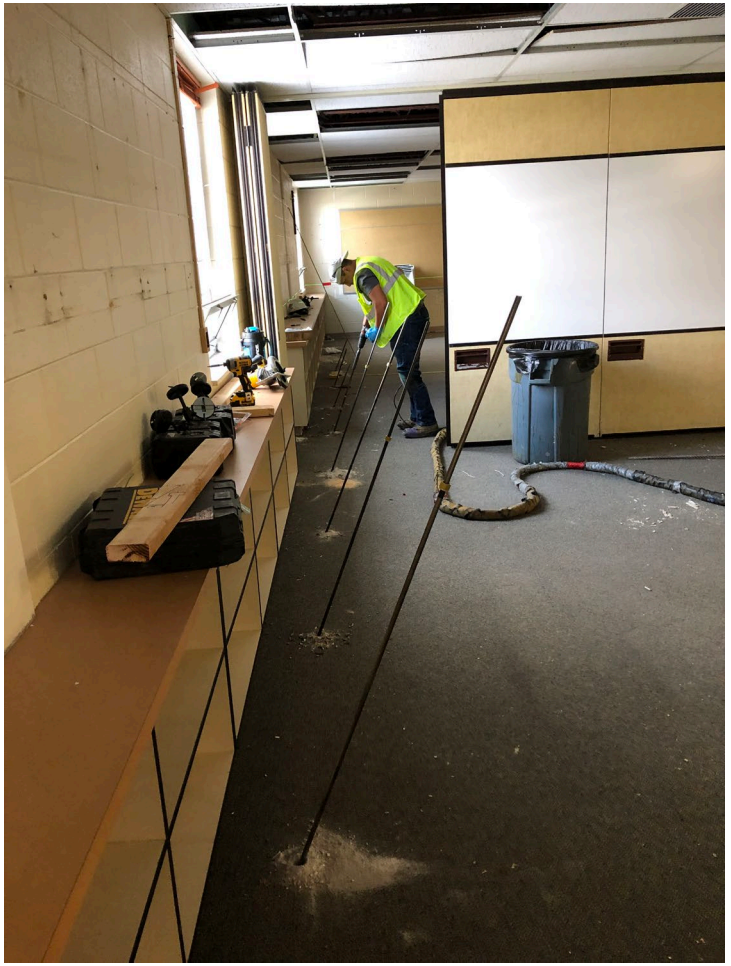
In some cases, low output machines are capable of handling shallow (-2’ to -6’) DI work. For greater DI depths (-10’ plus), a higher output machine is recommended.



Ability to Perform

Many projects require bonding or insurance which can get expensive. DI projects typically require much more material than traditional lifting.

Make sure you can take on those costs on the front end and charge for them in the bid.



Pre-Job Inspections & Estimating

Site Survey

When did you first notice the problem?

Is it worse with weather or seasonal changes?

Have there been plumbing problems or repairs?

Do you have a structural or geotechnical report?

Where are utility lines?

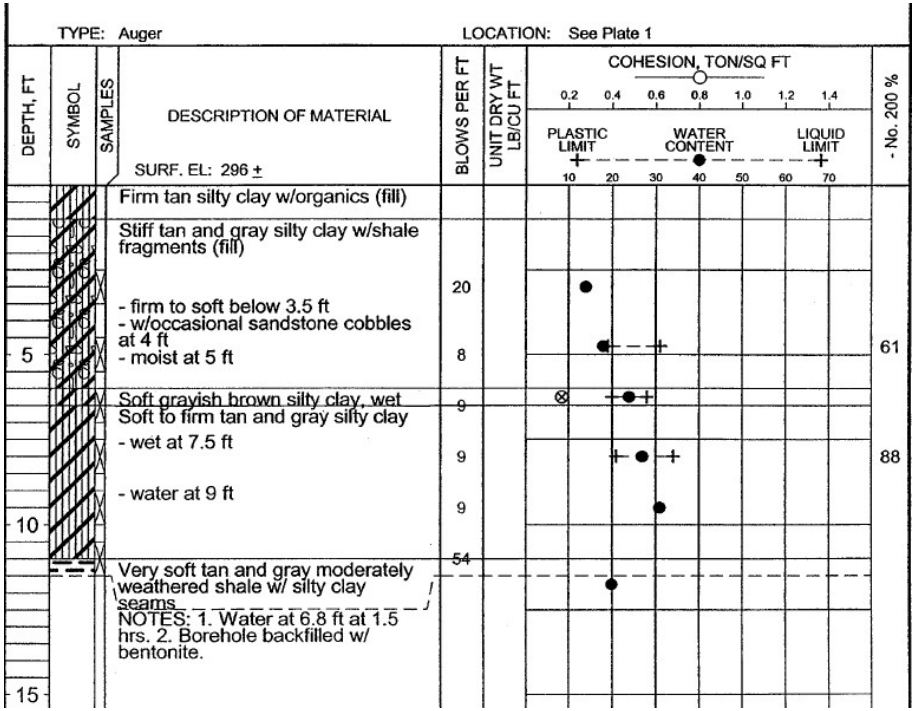
Pre-Job Inspections & Estimating

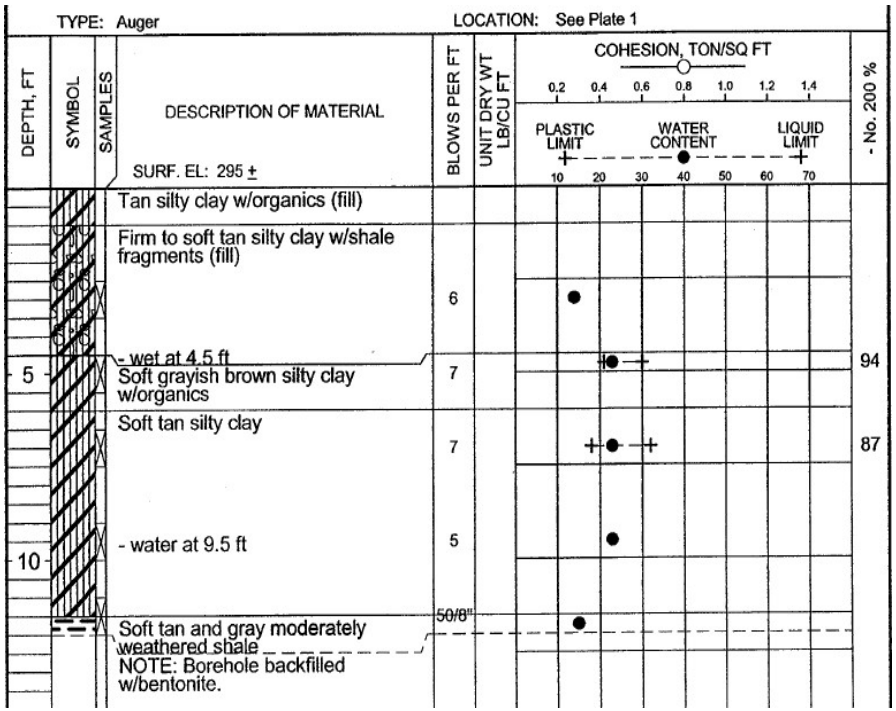
Determining the Underlying Soil Issues

- Dynamic Cone Penetrometer (DCP) testing
- Charge up front for pre-injection tests done for estimating purposes then roll into the price if they accept your proposal
- Is Water Present
- How many levels of injection will it take

Pre-Job Inspections & Estimating

Soil Boring Logs





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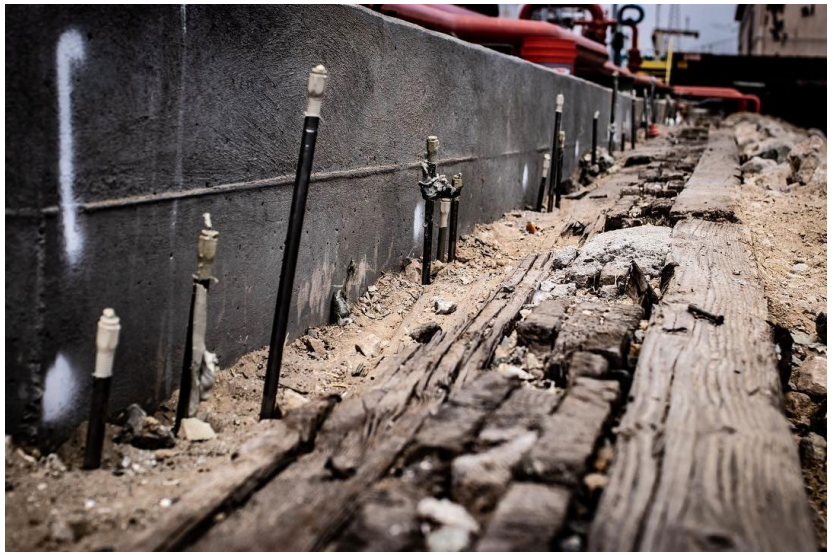
Set Customer Expectations

- Define success - What will a positive outcome look like
- Lifting structures with DI takes more foam than Slab Lifting
- Stabilization-only as an option
- You can have more confidence in the longevity of your repair with true densification of underlying soils; -2’ or -3’ makes all the difference in a successful project



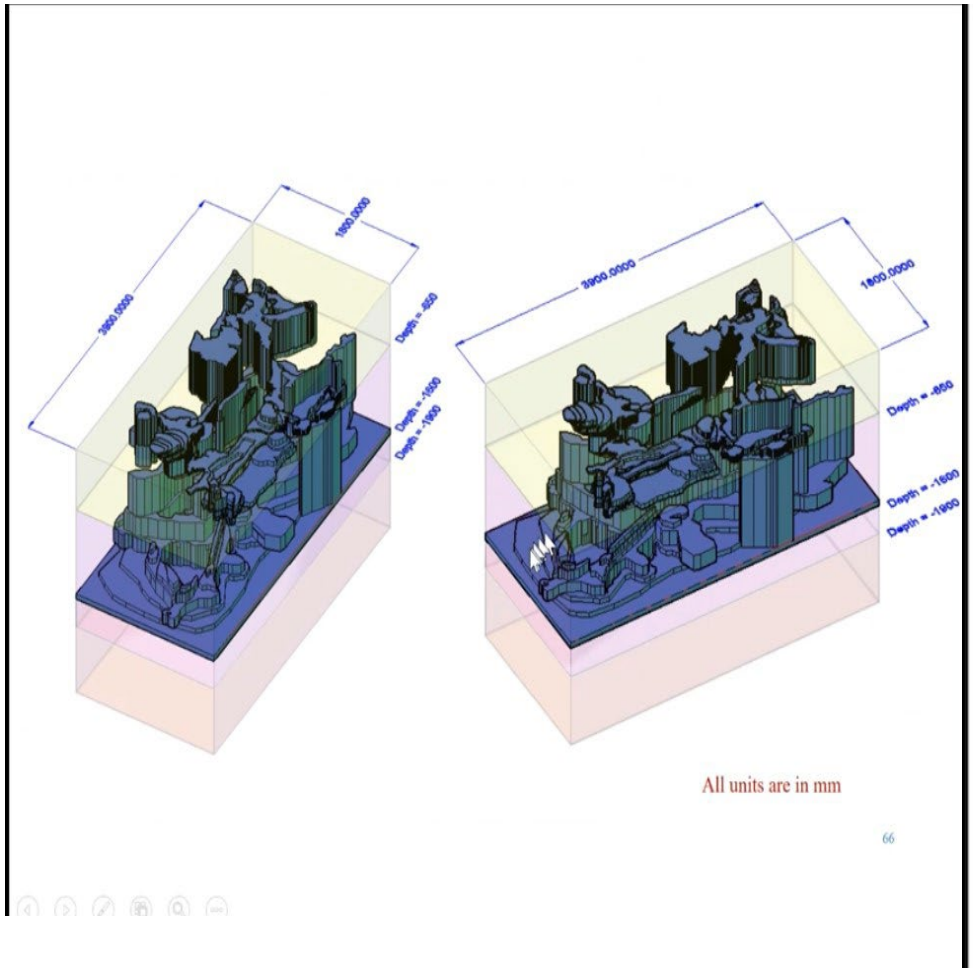
Estimating Quantity

- Rule of thumb is 25-75 lbs. per injection point but can range from 10 lbs. to 250 lbs.
- Higher end for very loose soils; lower end for dense soils or clay
- The deeper you go you may find it takes more or less per point
- Example (estimate):
  - -2’ to -10’ = 40 lbs. per point
  - -11’ to -15’ = 45 lbs. per point
  - -16’ to -20’ = 50 lbs. per point

Estimating Quantity

- **There is a 2 x 2 grid of injection locations 3 levels deep. How many injection points will there be?**
- **2 x 2 = 4 locations**
- **4 locations x 3 levels = 12 points**
- **45 lbs. x 12 points = 540 lbs.**

End Results



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End Results

Thank you!

Questions?