Roadway and Approach Embankment Ground Improvement Applications

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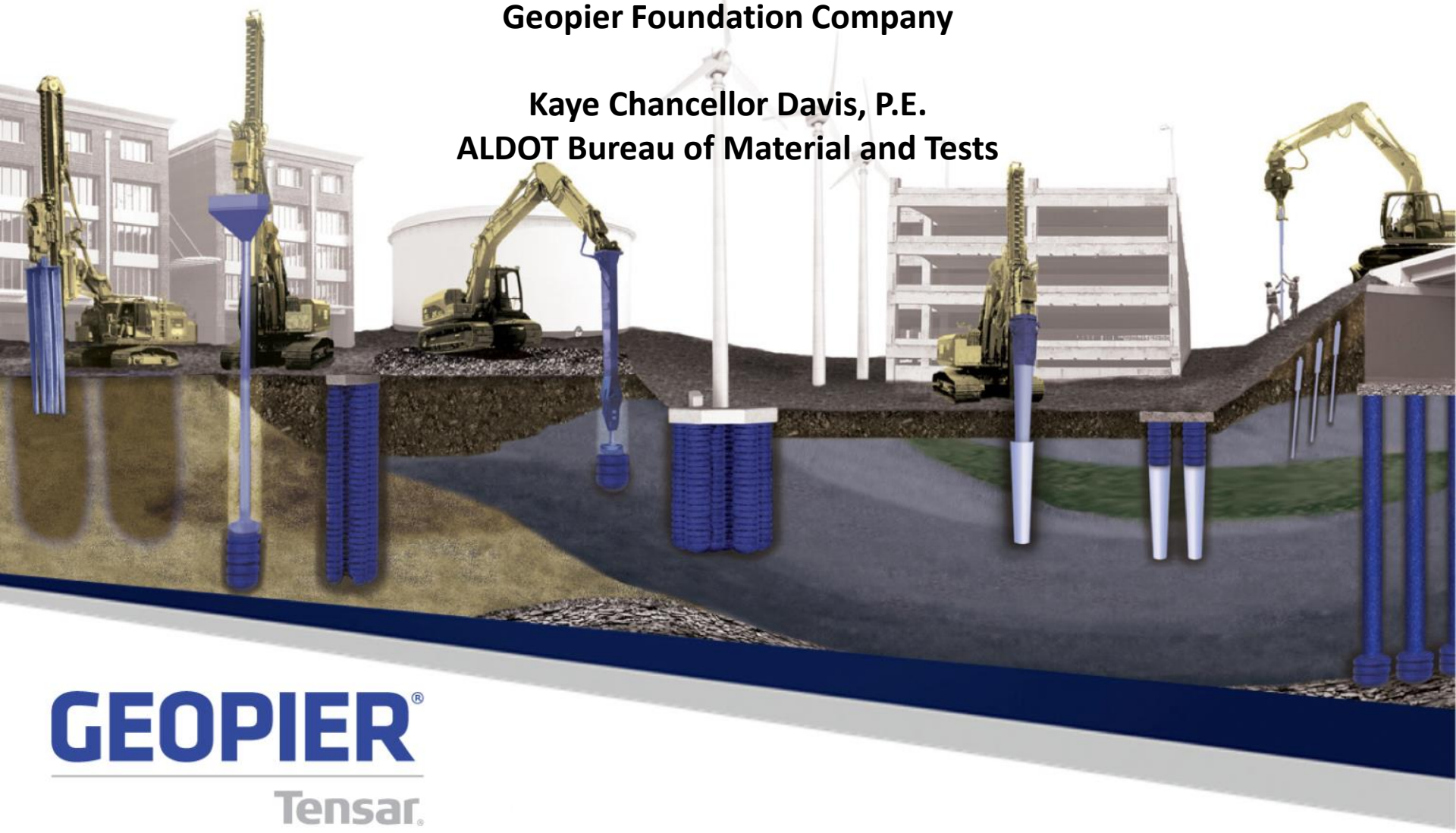
ALDOT Bureau of Material and Tests



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Tensar.

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Outline

- What is the Geopier® system?
- How do they behave?
- How are they constructed?
- What are potential applications?
- Recent Alabama DOT projects

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What is the Geopier® system

- Ground modification system
- Comprised of gravel
- Behaves differently than deep foundation piles
- Geopier the only **Rammed** Aggregate Pier®
- Ramming makes the difference

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What is the Geopier® system

- Multiple technologies to address a range of soil conditions
- Proven performance – Over 25 DOTs
- Accelerated construction schedules
- Cost-effective and Flexible solution
- Design-build capabilities
- Construction is clean – little to no mess to clean up
- Eliminates unfavorable design requirements

Roadway and Embankment Applications

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- RAP transportation solutions for 25+ DOTs
- Over 50 projects and 100 MSE walls for DOTs
- Only ground improvement technology with HITEC evaluation
- High levels of quality control / verification testing
- In-house design build solutions by P.E.'s

Mitchell Interchange, Milwaukee, WI

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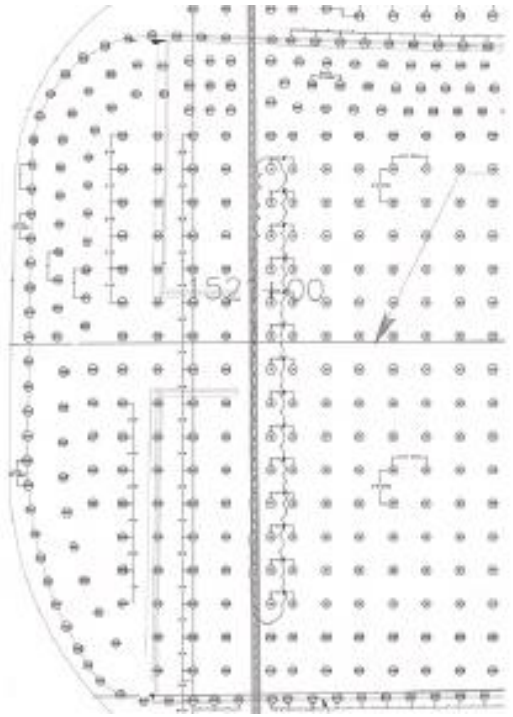
Engineering Support

- Kord Wissmann, PhD, PE, D.GE – Chief Engineer
- Brian Metcalfe, MS, PE – VP of Engineering
- Rupesh Kadam, MS, PE – Area Manager
- Bill Beckler, MS, PE, GE – Region Engineer
- Mandi Petrella, MS, PE – Region Engineer



RAP typical layout

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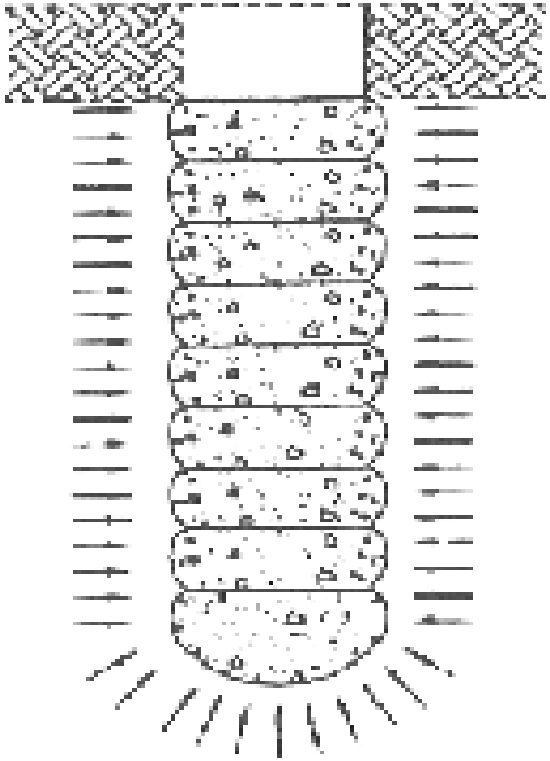
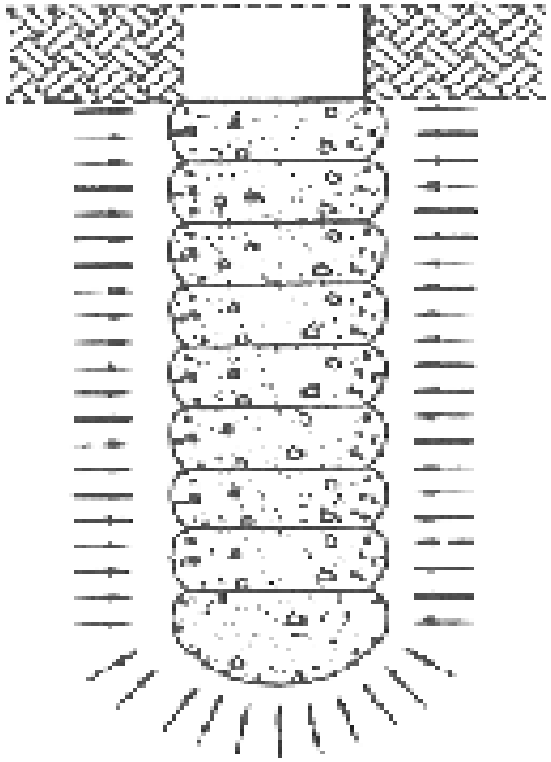
Behavior



Roadway and Embankment Applications

Increases lateral stress (lateral confinement) in the matrix soil to resist bulging of the Geopier® element when loaded



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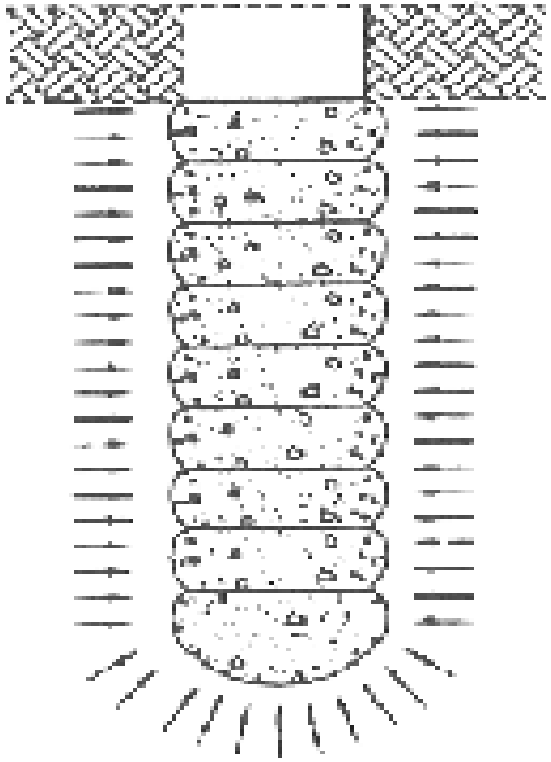
The installation method pre-strains the soil.

Similar to surcharging the soil without the surcharge load or time duration.



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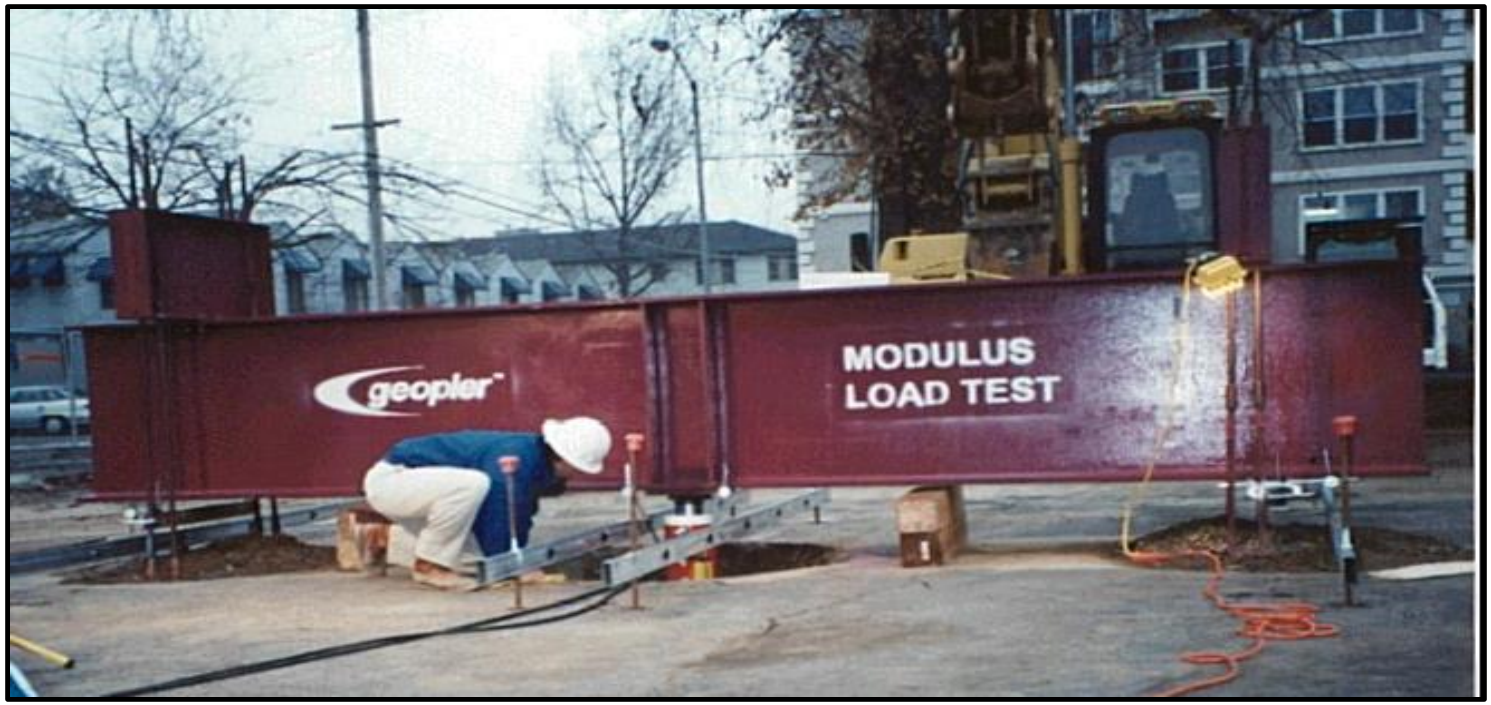
Measure stiffness with modulus test



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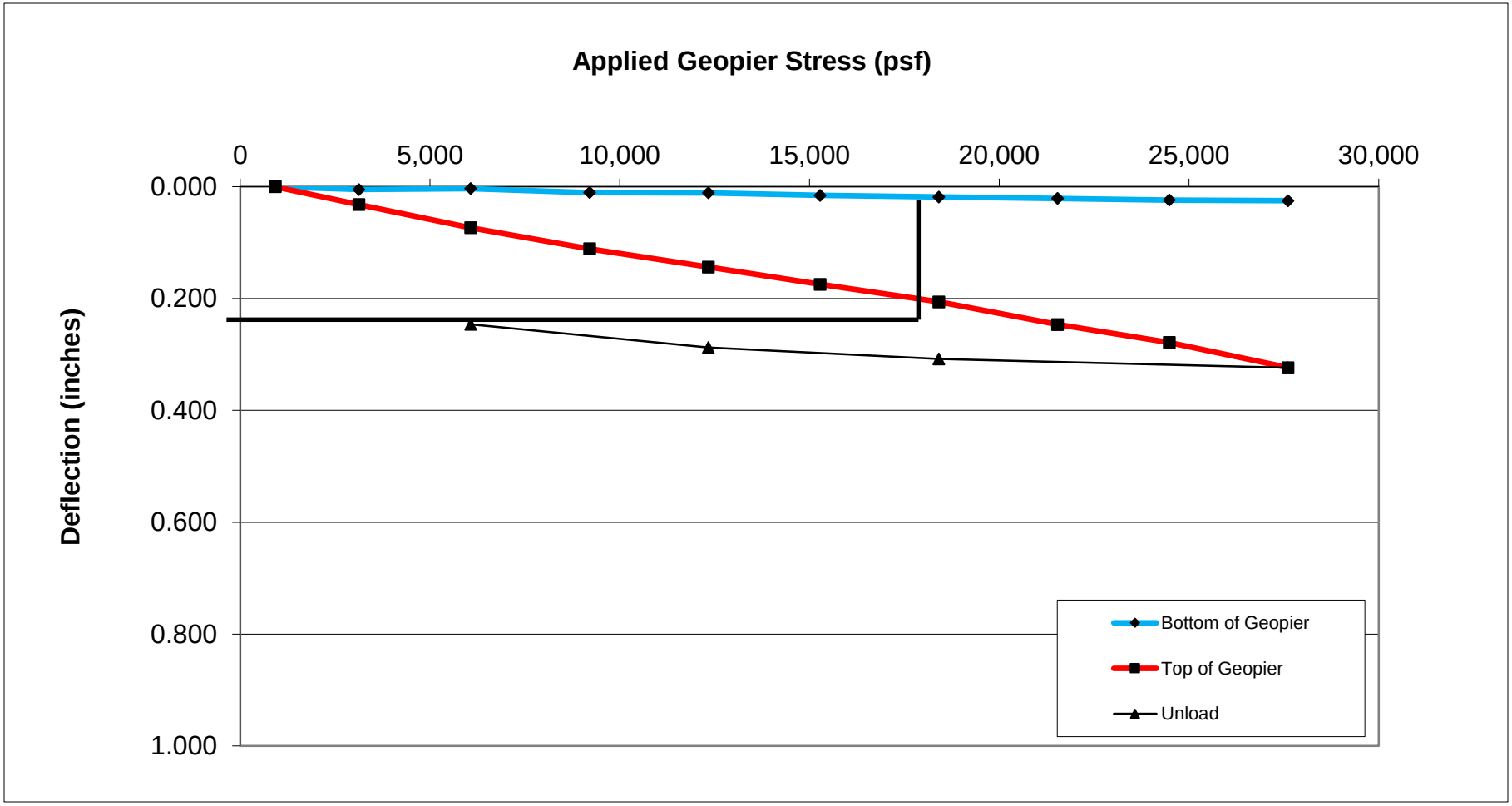
MODULUS TEST RESULTS



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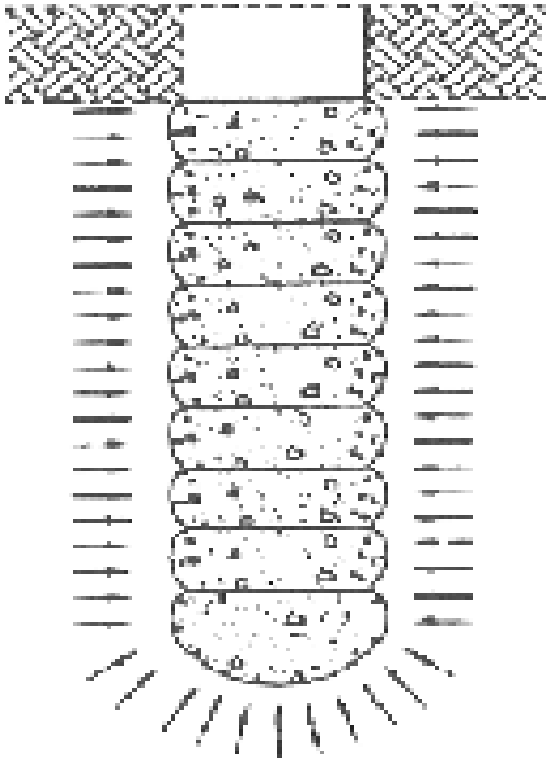
Construction



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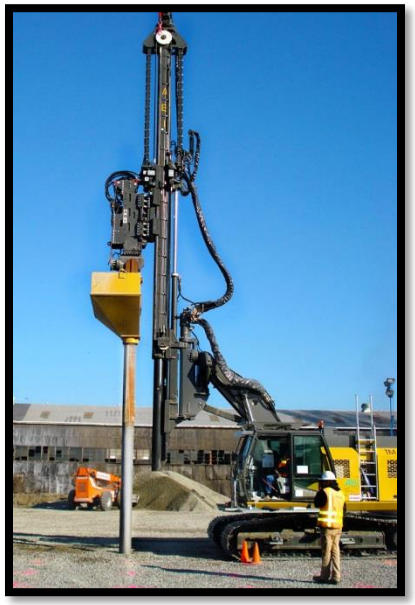
Rammed Aggregate Pier® Systems

GP3® System

GP3™



Impact® System

IMPACT®

Rampact® System

RAMPACT®

X1® System

X1™

GEOPIER®
Tensar®

Rammed Aggregate Pier® Systems

GP3®
System

GP3™

Roadway and Embankment Applications

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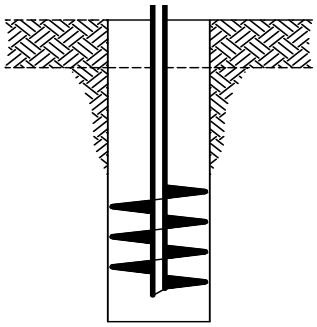

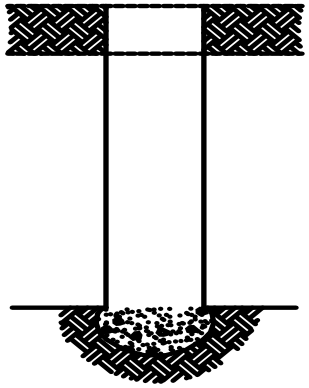

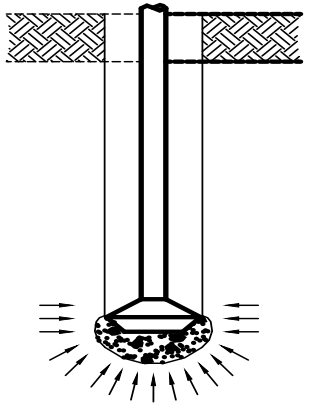

Excavate cavity

Open-graded stone

Tamp bottom bulb

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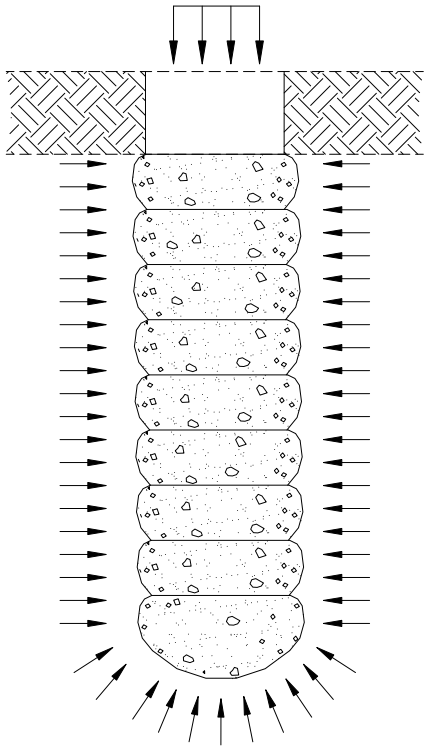
Rammed Aggregate Piers



- Creation of stiff RAP in matrix soils.
- Undulated shape
- Lateral pressure increase along pier increases frictional shear resistance

Roadway and Embankment Applications

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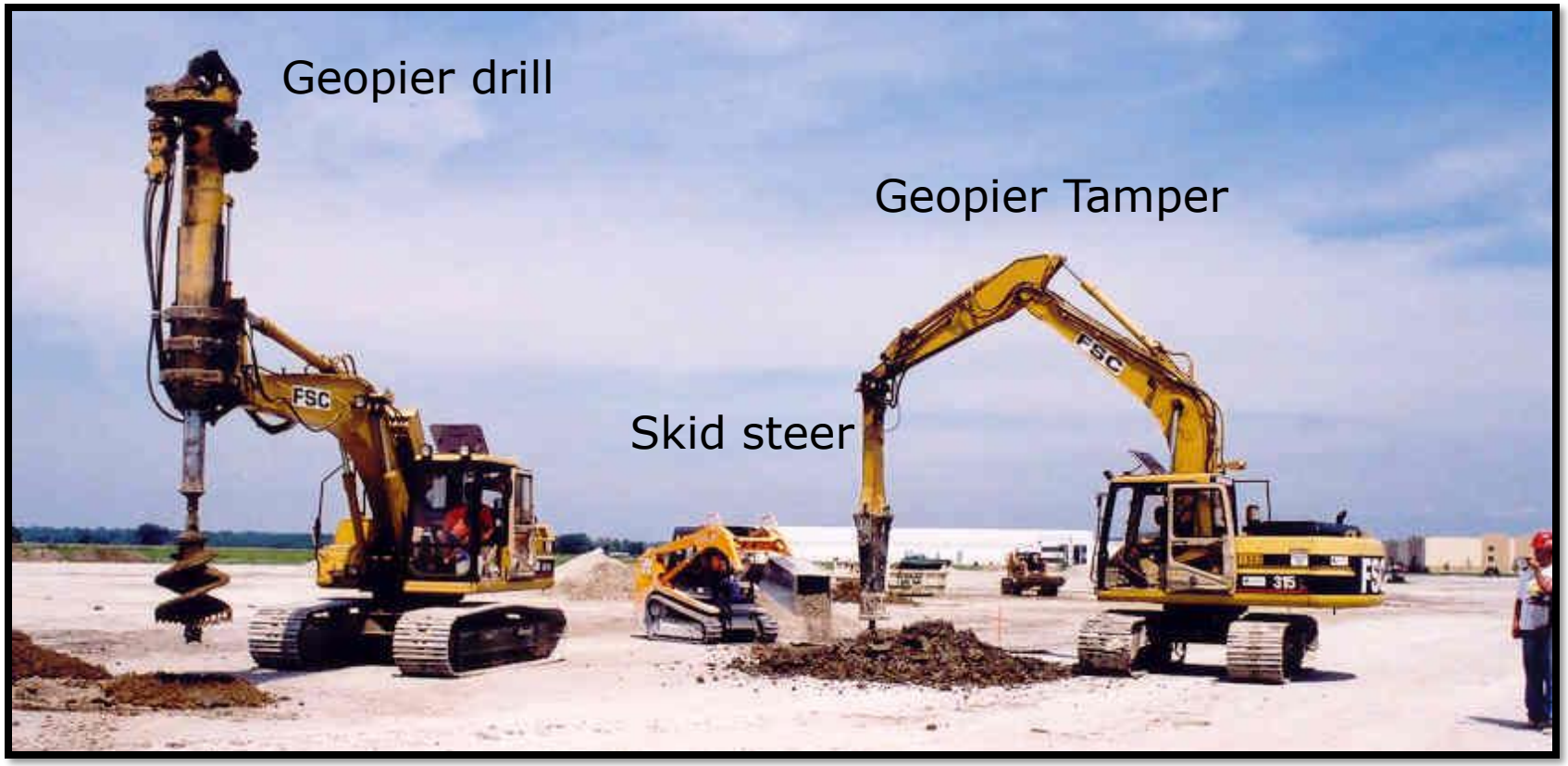

Mobile crew (4 people, 3 to 4 machines)

Rapid installations (30 – 100 per day)

24-inch to 30-inch installation diameter

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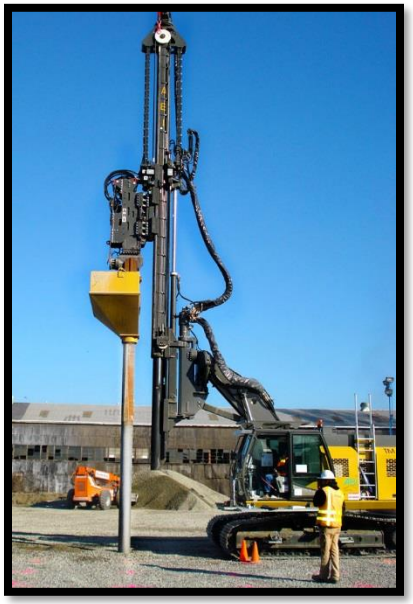
Rammed Aggregate Pier® Systems

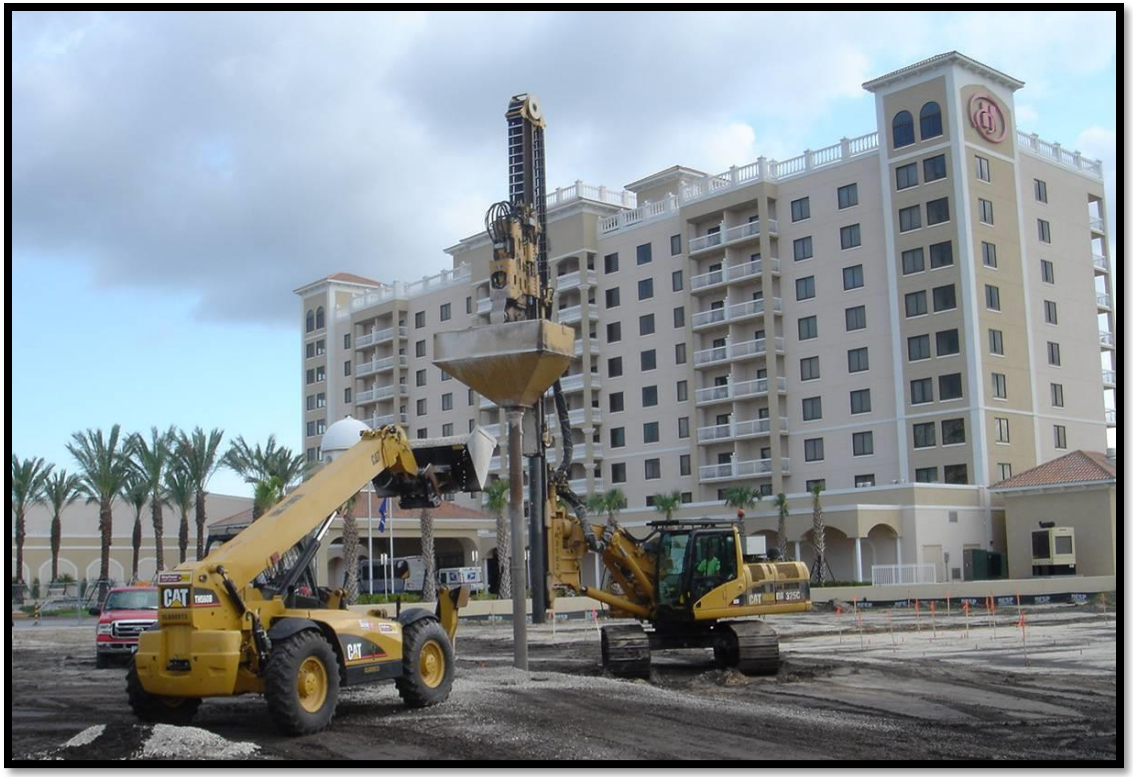


Impact®
System

IMPACT®

GEOPIER® Tensar

IMPACT® SYSTEM



Clean dry method.

Well-suited for high-groundwater conditions.

Eliminates the need for casing.

Roadway and Embankment Applications

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- Displacement method
- Depths up to 45 ft
- Dry process (no water jetting)
- No spoils (brownfield sites)
- Rapid installations
  (40 – 100 piers per day)

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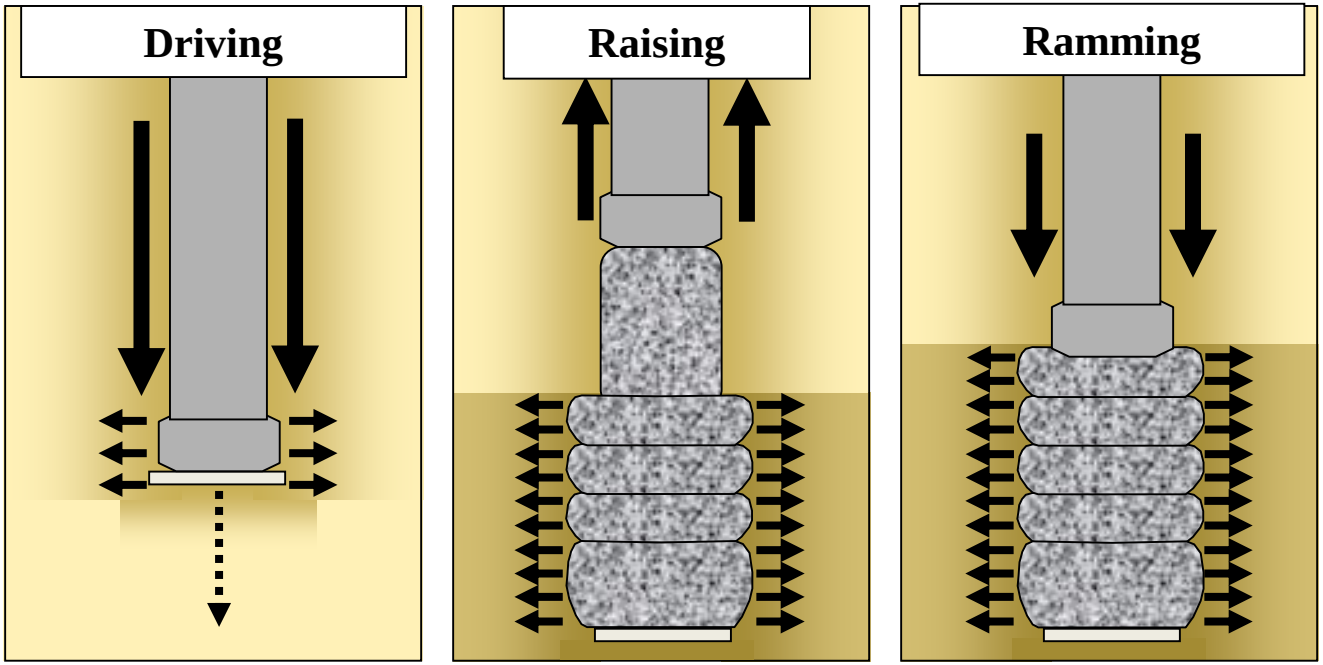
Vertical ramming with high downward crowd pressure



Positive lateral displacement:

Densifies and pre-stresses the matrix soil

Further stiffens the densely compacted lifts.

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Rammed Aggregate Pier® Systems

X1®
System

X1™

Roadway and Embankment Applications

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Same soils as GP3® system.

Depths up to 45 ft (no tripping out of hole).

Rapid installations (30 – 50/ day)

Good in mixed soils.

Eliminate casing risk

Roadway and Embankment Applications

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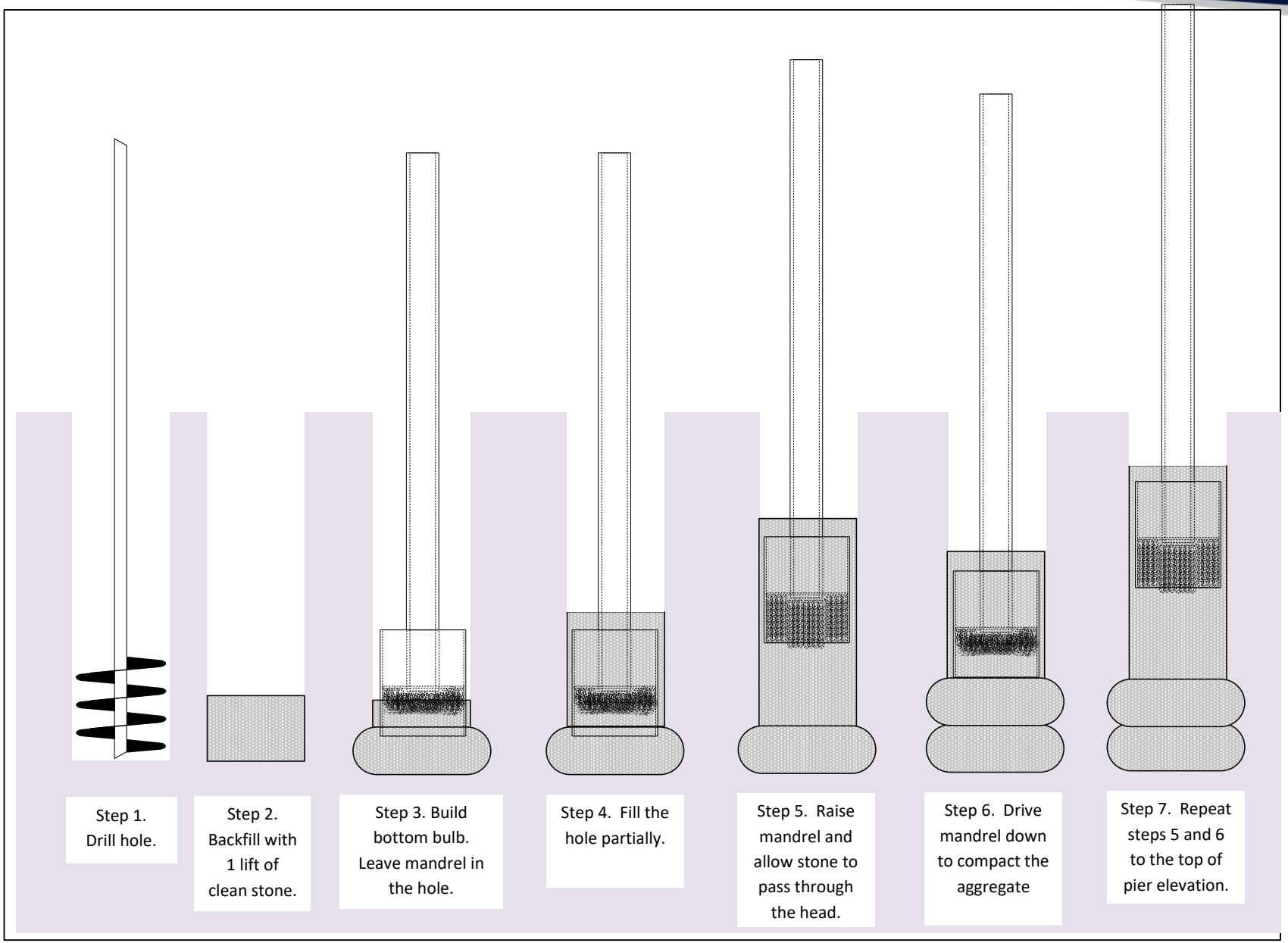
Tensar.



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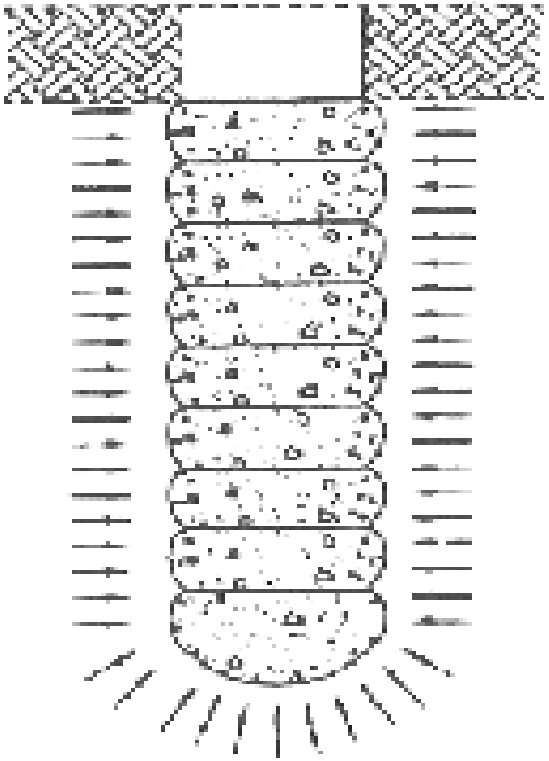
WHERE CAN *RAP*® ELEMENTS BE USED?



Roadway and Embankment Applications

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Embankment Support

- Increased global stability
- Settlement control
- Accelerated settlement

MSE Wall Support

- Stability Improvement
- Bearing capacity increase
- Settlement control
- Accelerated settlement

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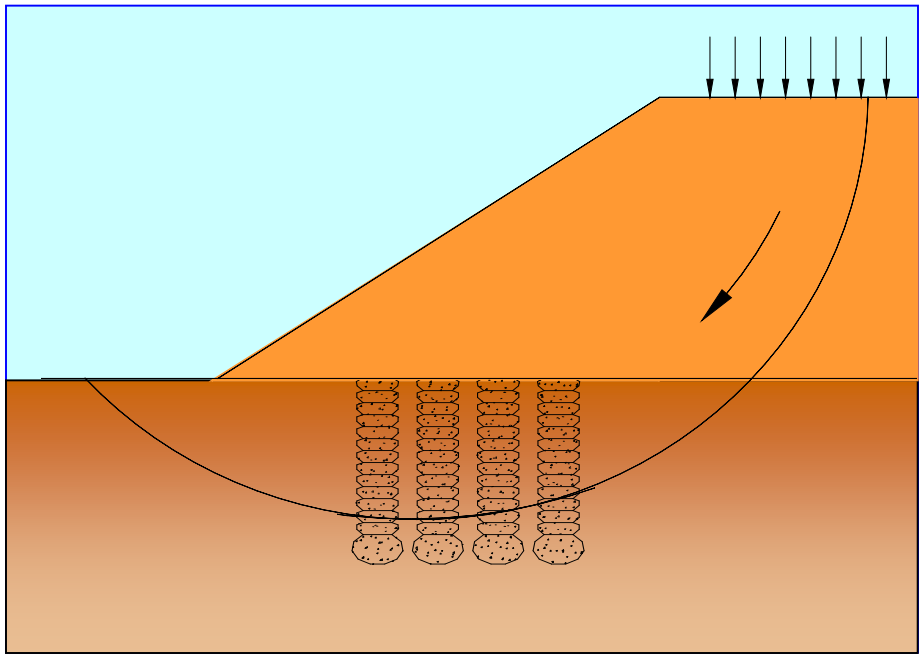
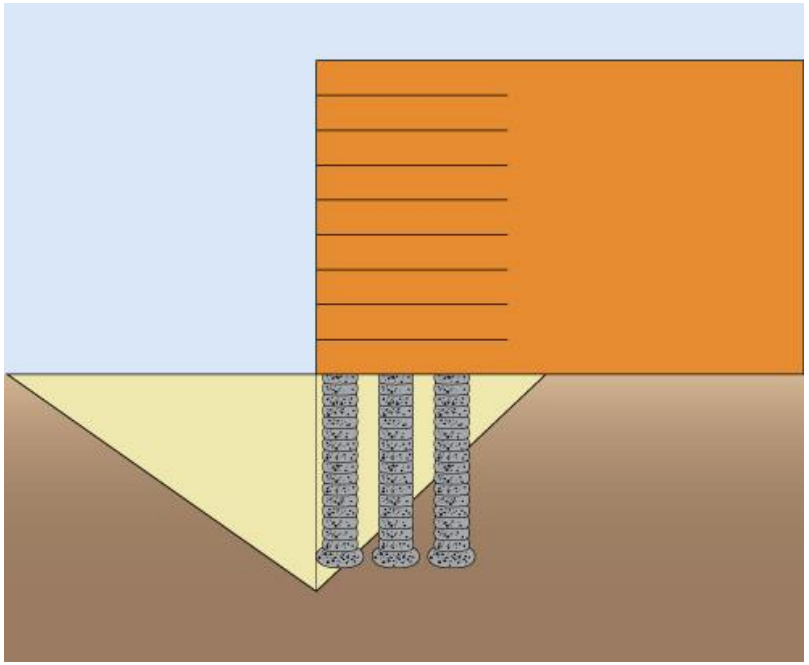
Improved Bearing Capacity, Global Stability, Settlement Control, Drainage





- High friction angle of RAPs increase resistance
- Install at spacing to achieve design FoS
- $\phi_{comp} = \arctan [R_a * \tan(\phi_g) + (1-R_a) * \tan(\phi_{soil})]$

Roadway and Embankment Applications

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- **Highway Approach-Ramp Stabilization**
- **Reinforce unstable slopes**
- **Provide bearing support for MSE Walls**
- **Reduce bump at the end of bridges**
- **Support box culverts**

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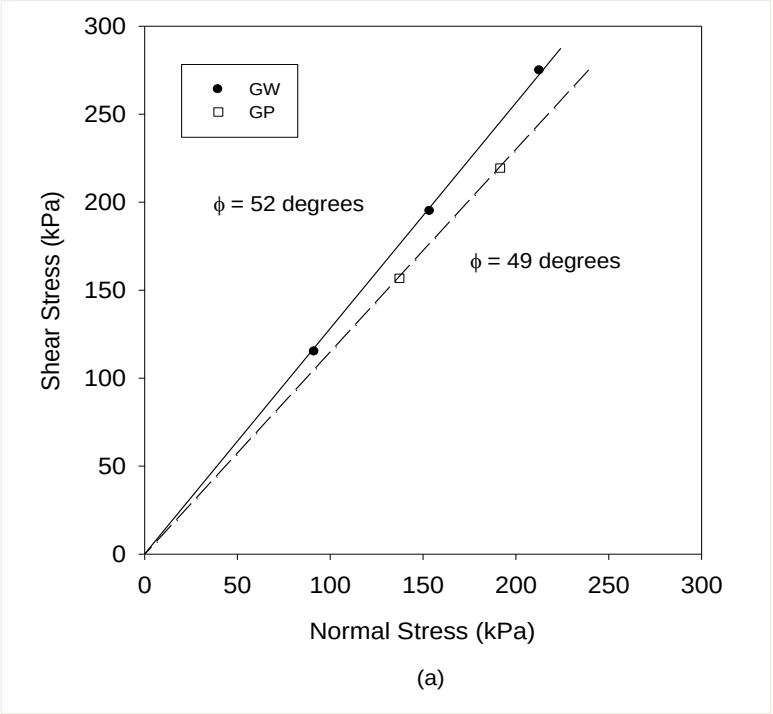
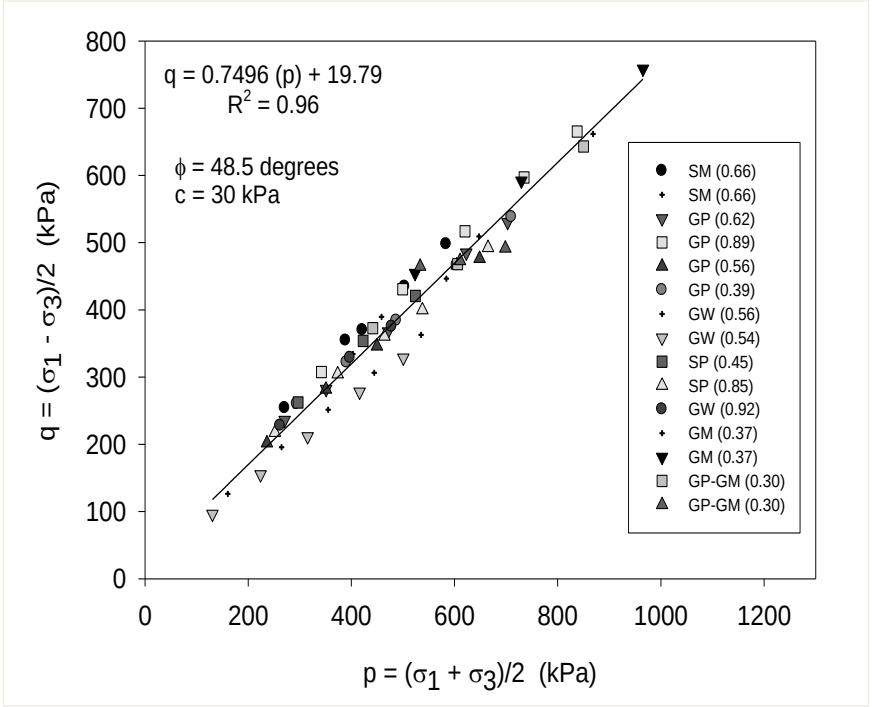
Direct Results



Full-scale top-of-pier direct shear test results (Fox and Cowell 1998)



Laboratory triaxial shear tests (White et al 2002)

Friction angle = 48 degrees (o/g stone)
= 52 degrees (w/g stone)

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Birmingham Northern Beltline

Birmingham, Alabama

- 1700 ft MSE wall up to 32 feet high next to Self Creek.
- 1380 Geopier elements installed.
- 10 to 15 ft of very soft silty clay with isolated areas of 40 ft of very soft silty clay.

Owner: ALDOT

Geotechnical Engineer: AMEC

General Contractor: Wright Brothers Construction

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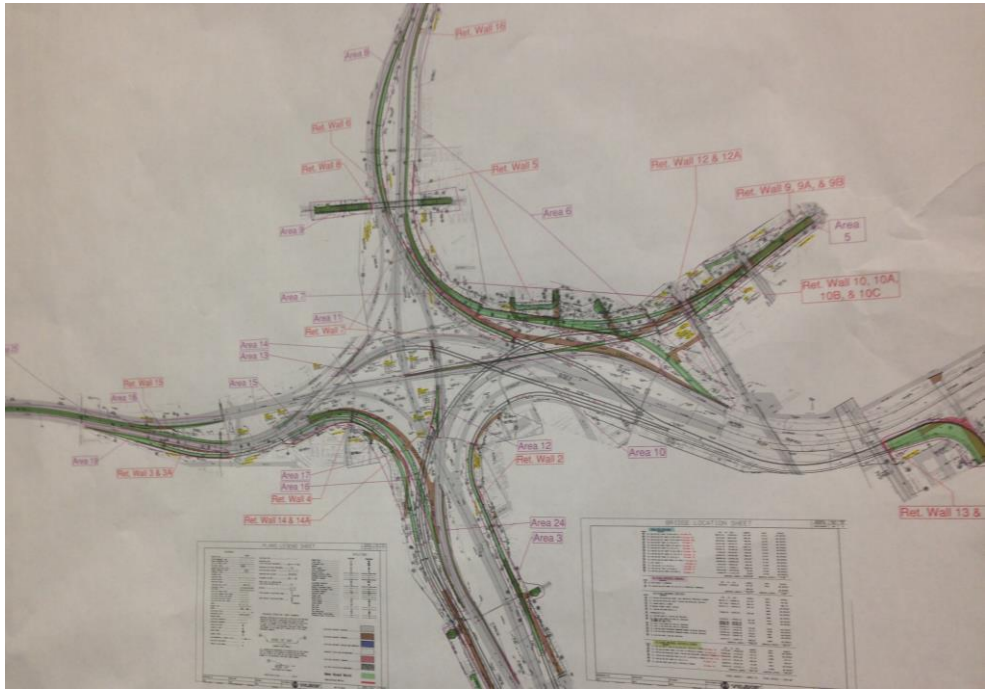
I-59 / I-20 Interchange and Bridge Replacement

Birmingham, Alabama

- 6 ramps. Ramps 2, 3, 4, 10, 13, 14
- 4200 Geopier elements installed.
- Clay fill overlying fat clay.



Owner: ALDOT

Geotechnical Engineer: Terracon, AMEC,

General Contractor: Granite Joint Venture

Roadway and Embankment Applications

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I-65 Widening, Shelby Co, AL

I-40 / I-240 MSE Walls, Memphis, TN

Loop 363 at IH-35 MSE Walls, Temple, TX

US90 at SH6 MSE Walls, Sugarland, TX

Picardy Ave / I-10 MSE Walls, LA

US392 & I-25 MSE Wall & Embankment, CO

I-40 / I-55 Interchange, W. Memphis, AR

I-69 Mainline MSE Wall, IN

US169 & I-494, MN

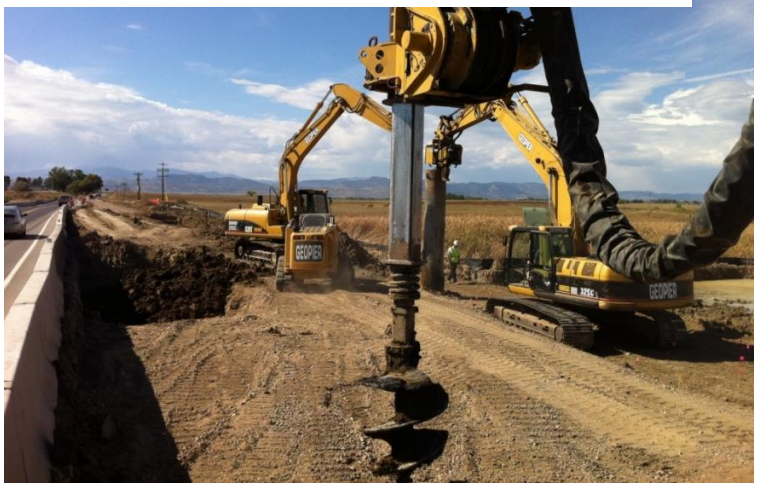
Highway 880 MSE Wall, CA

I-235 / 50th St. MSE Walls, Des Moines, IA

I-70 / I-270 MSE Wall, St. Louis, MO

Route 162 MSE Walls, Troy, IL

Colorado SH392 / I-25



CALTRANS I-880