



**Rembco**

Geotechnical Contractors, Inc.

# The Stabilizing Force

A Bulletin of Geotechnical Know-how

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## New Addition to the Family



Rembco recently added a very versatile piece of equipment. It's a Casagrande® C7 hydraulic crawler drill. We didn't buy the C7 because it's loaded with state-of-the-art features (it is), or because it has awesome power (it does), or even because of its capacity for overburden drilling (it's got it.) We bought the drill to save time and money – yours.

### Keep on Drillin'

On a geotechnical construction site, progress is pretty easy to spot. When the rigs are advancing drill rod or pumping grout, the crew is producing — everybody is happy! But some tasks common to drilling are notorious for bringing production to a standstill: installing additional drill rod, transitioning from drilling to grouting, and moving to set-up on the next hole. All three activities mean that production stops until the drill begins turning or the pump begins pumping.

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## Subsidence can be Unsettling

### Some options for getting back on stable footing

It's a nightmare. You stare blankly at your home or commercial building and your mind tries to deny what your eyes are clearly telling you: one part of the foundation is unquestionably lower than the rest. If ever you had a "sinking" feeling, this is it. But, before that sinking feeling gets you too far down, let's take a look at a couple of ways to solve your problem.

### Helical Piers

One of the most inexpensive ways to restore support for a settling structure is with helical piers — steel, screw-in pilings that can be installed, to transfer the load from the inadequate soil immediately under your foundation, to soil or rock that is better able to support it.

A series of helical piers are strategically placed at intervals under the structure's foundation. Typically, each one is screwed in to a prescribed torque rating or to the point of refusal. A jack is then bracketed to the pier and to the foundation so that the foundation can be "jacked-up" or preloaded, transferring the weight from the soil onto the pier.

In cases where slight subsidence was not a sudden event, but occurred over a period of years...

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# Resisting Lateral Earth Pressure

## What's the Right Retaining Wall for Your Site?

Just about every structure starts with an excavation, and the various cuts and slopes involved can be unstable or even dangerous if not properly addressed. The culprit behind this instability is Lateral Earth Pressure — the pressure that soil exerts sideways. It's a force that must be reckoned with using proven scientific principles, but designing and installing retention systems is something that we geotechnical construction folks do every working day.

### Dealing with Horizontal Stress

"To design the best retention system," says Rembco Chief Engineer Mike Bivens, "we have to determine what kinds of horizontal stress conditions will be exerted on the system. There are three main situations related to horizontal stress. Engineers use the coefficient of lateral earth pressure to calculate how much horizontal load the soil places on a structure. The amount of pressure on a structure varies with the soil and type of structure. In the case where a wall is heavily braced and is not allowed to move as earth pressure builds, an 'at-rest' earth pressure develops. However, if the structure is designed to move slightly after construction, as the soil moves and creates outward pressure against the wall, an 'active' earth pressure develops. That 'active' case generates a lateral earth pressure that is much lower than the 'at-rest' case. In other cases, the direction of the force is reversed, ie the load from a structure pushes into the soil, moving the soil out of the way. This is called the 'passive' case and it generates a high earth pressure. "The active and passive pressures define the range of stresses that may be exerted in a horizontal plane," says Bivens.

A large part of geotechnical construction falls under the heading of Earth Retention, that is, supporting cuts or fills at strengths greater than what is possible through soil strength alone. To determine what type of earth retention system is required for a given project, Bivens considers a number of factors, from soil properties and stress history, to the required height of a wall, to how much space is available for construction. "Once we make a thorough assessment," says Bivens, "we can recommend the best type of retention system to stabilize the specific conditions."

### That's Classified

Retaining walls are most broadly classified as fill walls or cut walls. Fill walls, the more traditional type, are built from the bottom up, while cut walls are constructed from the top down. Examples of fill walls include Gravity Walls, in which the mass of the wall and gravity alone provide the stability. A cantilever wall draws its stability not only from mass and gravity but also from a portion of the wall being embedded. A Mechanically Stabilized Earth or MSE wall also relies on mass and gravity, but gets substantial strength from being tied-into the backfill with geogrid or reinforcing fabric.

Cut walls, on the other hand, are built from the top down. The excavation is normally performed in four to five foot "cuts" running along the entire length of the future wall. Each cut is stabilized using methods, such as, soil nailing, rock anchors or pile and lagging before the next cut is made. Another very cost effective option, pioneered by Rembco, is using compaction grouting to improve the lateral strength of the soil before excavating.

"Each project presents a new challenge. No two walls are exactly alike," says Bivens, "but we make these decisions based on proven science and our experience. Selecting a technically appropriate and cost-effective type of retaining wall is what Rembco does day in and day out."

If you have a construction project, you're likely dealing with lateral earth pressure. For a recommendation on how it can best be stabilized, call Rembco Chief Engineer Mike Bivens: 865-363-4708 or e-mail [mike.bivens@rembco.com](mailto:mike.bivens@rembco.com)



## Preparing for The Big One

Rembco Geotechnical Contractors just completed design and installation of a micropile foundation system for TVA's Watts Bar Nuclear Power Plant in Spring City, TN. The structure is called a FLEX Equipment Storage Building (FESB). Its purpose is to provide secure storage for emergency response equipment that will keep the plant operating after a natural disaster, such as, earthquake, flood or tornado. This is TVA's first FLEX building, but many others are being planned around the USA...and they are *serious* about it.

The FLEX structure's 3.5 ft thick base slab is 110' x 110'. It bears on a deep foundation system designed to avoid liquefaction induced settlement that might result from a 10,000-year seismic event...with a ground acceleration of 1.18G! That seismic acceleration rate would create a lateral load of nearly 3,600 kips (3.6 million pounds) and the micropile system must resist that loading with no more than 1" of lateral deflection! Of course, that load could happen in ANY direction and must be resisted while the piles are loaded fully in compression. (I told you they were serious!)

While some of our competitors proposed a simple, rather bulky system of large diameter micropiles, Rembco did what we do best. Seeing an opportunity to value engineer a system that would meet the client's performance requirements while holding down cost, we used a very sophisticated approach involving *Pile Group Analysis Modeling* to calculate and optimize the performance of an integrated group of elements. Based on the results of this model, we proposed a strategic combination of 147 piles, varied in size, to support the vertical loads. To handle the lateral loads, reinforcing steel sleeves were fitted over the upper 20' of some of the micropiles.

A fast construction schedule was very important to the owner, so Rembco committed two micropile drill rigs for the project. A 60-ton cement silo was employed to make high-volume grout-batching fast and efficient. Once these resources were combined with the right people, our installation was completed in 30 days...15 days earlier than the 45 we promised!

In addition to the pile installations, Rembco performed vertical and lateral load testing to verify design parameters and to validate Rembco's drilling and grouting methods. The results proved a factor of safety well in excess of our design goals.

In summary: we helped our client to meet their objectives while saving some money, we did so safely, beat their required time line by 50% and broke ground in a new and desirable market niche.

Whether your situation requires immediate response or patient, comprehensive planning, let Rembco be your first phone call. For deep foundation systems, The Stabilizing Force (Rembco) is always a solid place to start. For evaluation of your project, call our Lead Estimator and Project Manager, James Grubbs, at 865-671-2925 or e-mail [james.grubbs@rembco.com](mailto:james.grubbs@rembco.com)





## New Addition to the Family

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### Designed to Reduce Downtime on All Fronts

**First**, with the new Casagrande®, installing additional drill rod is avoided altogether. While most drills work in 10-ft. increments or less, the C7 is equipped with a drill rod that will punch 30-ft. holes in one pass.

**Second**, for deeper holes, a mechanized carousel stands at the ready with two additional 25 ft. rods and a hydraulic loading arm. Together, they make the process of adding drill rod simple and fast. With this system, we can drill 80 ft. without handling drill rod. It's the only one of its kind in the USA today!

**Third**, the time required to load, unload and position the crawler rig is reduced by providing the operator with a remote control panel. Whereas most drill rigs have mounted control panels that restrict the operator's view and mobility, the C7's wireless remote allows the operator complete freedom to walk around while moving it from site to site. He can see for himself exactly where the drill needs to be, how to get it there, and he can put it on the spot, by himself. The operator has better visibility, less dependency on spotters, and less chance of miscommunication between driller and helper.

**Fourth**, the C7 is designed for "through the head" grouting, a feature that greatly reduces grouting time by eliminating several labor intensive steps that are required for manual grouting.

**And, finally**, a newly designed joints system allows for a great deal of flexibility in how to set up on the hole.

As a result, the C7 is faster, easier and safer to operate. The rig even has full kinematics in the long mast configuration! (OK, I'll translate...you can drill with a 90-ft. mast laid sideways without turning the rig over.) Chances are, we would never test that capability, but that kind of stability is a real plus when installing soil nails or rock anchors along a narrow bench or when working in extremely narrow spaces.

All in all, we think our new baby is the most beautiful little girl in the whole wide world. But, more importantly, we think that it will help us to provide you with better and safer service at a better price. We look forward to hearing from you.

## Subsidence can be Unsettling

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...and where the structure is relatively light, helical piers can often provide the additional bearing capacity needed to stabilize the structure.

### Getting it right

"When helical piers are installed in loose soil, they lose most of their holding strength," explains Rembco Chief Engineer Mike Bivens. "That's because they have no side friction. Even if you turn them all the way to rock, if the surrounding soil is loose, all the load rests on the small tip of the pier. That's a recipe for failure."

"We've got nothing against helical piers," says Bivens. "If we find that the structure, geology and topography are such that helical piers will clearly do the job, we'll recommend that solution."

Problems can arise, however, when a contractor tries to use helical piers where the job really calls for compaction grouting. Helical piers are a sound choice only when you're reasonably certain that the soil beneath your structure has sufficient load-bearing capacity. If there is doubt, you basically have two options: have a soil test performed by a geotechnical engineer, or simply choose compaction grouting...then you and your building can rest assured.

### Compaction grouting – Ground Improvement

Unlike helical piers that rely on existing bearing capacity to be effective, compaction grouting actually improves the bearing capacity of the weak soil into which your foundation is sinking. A series of small diameter (2" – 4") steel casings is advanced through the weak soil to a stable soil or rock. While each casing is slowly withdrawn, a stiff mortar-like grout is injected at predetermined pressure to displace and compact the surrounding soils. When these injections are done in a prescribed pattern, the weak soil is squeezed sideways and pushed upwards...effectively increasing the soil density and bearing capacity of a wide area. With this type of compaction grouting, we not only put your structure back on a stable footing, we can even raise it back to its original position!

### Compaction grouting – Compaction Piles

To a casual observer, the activities of a ground improvement crew and a compaction piles crew look almost identical, but the processes and purposes are different. Compaction piles are strategically placed at intervals under the structure's foundation. Pipe is either drilled or pushed down to competent rock (not just to a stronger soil). Then, the pipe is pulled-up in incremental "lifts." At each lift, grout is injected at a specified volume. Steel rods are inserted the entire length of the pile, and then after the grout hardens, jacks are installed — connecting each pile cap to the foundation. As with helical piers, the foundation is then pre-loaded. Compaction piles do not provide ground improvement. They provide a solution that is not dependent on bearing capacity because the weight of the structure is transferred directly to bedrock.

### The Choice

Each approach has its own strengths and limitations. Sometimes a combination of two or three approaches is the best solution. You now have a better grasp of the options that are available when you or someone you know gets that "sinking" feeling. And, hopefully, you will be better equipped to reach the best decision. At Rembco, we believe that an informed client is crucial to finding the best solution...one good reason to make us your first call when you are facing a tough geotechnical problem! For a soil test, a visual assessment (free of charge in the Knoxville area), or just an initial conversation about your situation, contact our Chief Engineer Mike Bivens: 865-363-4708 or [mike.bivens@rembco.com](mailto:mike.bivens@rembco.com)