ABARENT
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# DISCUSSION ON UNDERPINNING (10/8/16)

The following are opinions of the writer related to various forms of underpinning and foundation stabilization. It should be noted that every situation requires an inspection and investigation process to determine foundation movement cause, the priority for remediation and process required.

Foundation movement occurs in varying degrees. An experienced professional should be consulted to assess the movement to determine the severity and provide remediation solutions as may be required. Abarent Construction Ltd. is experienced and qualified to assess your foundation's movement. Please enquire with us as to our qualifications, experience and any technical resources relevant to your project.

To fully appreciate how foundation movement can be remediated, one must understand the cause of the movement. Foundation settlement and movement can be caused by one, or a combination of the following:

1. Dehydration of the soil creating shrinkage of the soils causing settlement
2. Expansion of the soil due to too much moisture or frost action causing uplift of the foundation and it's components
3. Existing pile failure due to piles not being designed properly or improper installation
4. "Wash Out" of bearing soil due to water erosion and/or water and sewer line issues
5. Poor construction with weakened components not able of handling required loads
6. Existing Foundation components bearing on soft soils not capable of handling loads

There are other causes for foundation movement, but the above five are the most common. Once again, it is very important that all relevant information be analyzed by an experienced professional to determine what is occurring. Only then can an effective remediation plan be put together.

One of the most common solutions to stabilize the foundation of a building is to underpin the foundation down onto a more stable soil. This soil layer should be suitable by strength and type to accommodate the loads exerted on it. It should also be well below the "active soil layer". *"Active Soil Layer" is the layer of soil that is affected by seasonal changes in moisture levels. Most commonly this soil layer is within the top 20 feet of soil. Periods of drought or high periods of precipitation can drastically affect expansive clay or sensitive soils.*

Underpinning is typically done by installing a pile under the existing foundation. There are many forms of piles available. The following are some of the underpinning piles used in our industry:

**Helical Piers "Screw Piles"**

Helical piers are a very basic product. They consist of a shaft/pipe and a helix (which is much like a single rotation of a screw). Helical Piers "Screw Piles" were first used in England, invented and patented by Alexander Mitchell sometime around 1830. Some of the original installed piles

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installed in that era have been analyzed and have been found to have not lost any of their integral strength.

"Screw Piles" are installed at relatively low RPM with an increase in torque during installation. Sections are added as the pier is screwed into the ground. Once the predetermined depth and installation torques are reached the pile can be cut off and a load bearing plate or bracket is attached. When underpinning, this bracket can also be used to accommodate lifting the foundation to level building elements. **The latter is a definite advantage over some of the underpinning systems available**. Installation of the piles can be done with anything from small portable equipment to varying sizes of machinery such as a backhoe or skid steer. During the installation of helical screw piles, crews will record the pressure on the hydraulic motor and with that, the torque can be calculated. This installation torque has been shown to have direct correlations to installed pile capacity. A reputable company will only use this installation torque as a confirmation to an already engineered pile design based on a soils investigation.

Aside from little to no vibration and very little soil disturbance being a definite advantage of Helical Screw Piles, **these piles also resist upward forces**. This is especially important in expansive soil. The helix is anchored in competent load bearing soil and the frictional forces along the shaft are negligible compared to the end bearing force. On that note, the biggest advantage of Helical Screw Piles has to be the fact that **they are designed as a "True End Bearing Pile" only**. Any minimal "skin friction" on the side of the pile shaft is not calculated into the piles required capacity. The amount of weight the pile can handle is governed by the bottom of the pile (Helix plate). This creates confidence in the Helical Pier System to perform in soils where moisture levels change (which would change the parameters upon which any friction pile would work).

There are different manufacturers of Helical Piers and they are not all equal. Connection stiffness is of great importance as is pile design and stringent adherence to the manufacturing process. Our manufacturing company, Helical Pier Systems (HPS), dedicates considerable resources to their research and manufacturing process. HPS has offered engineering, manufacturing, equipment design, creation and distribution for helical piling products since 1977.

**Steel Pipe Push Piles**

Steel Pipe Push Piles are steel pipes driven into the ground by a hydraulic jack, which uses the existing foundation as a fulcrum for the downward force. As each pier is driven, the friction between the soil and the pier accumulates until it exceeds the load being placed on the pier. Push Piles are very effective in tight access situations where each pile installed can be load tested.

Be aware that there are many different variations of a Steel Pipe Push Pile. At Abarent Construction we have evolved our own proprietary Push Pile system to exceed all possible requirements. Some of the positive attributes of Abarent Construction Ltd's system are:

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- Abarent installs **Concentric Push Piers** installed & preloaded to design loads which will not induce eccentric loads into existing foundations which, based on observations that have prompted the identification of the need for underpinning, has probably already experienced significant deterioration in the form of fractures and vertical displacements.
- Pier Brackets are capable of **Bridging** foundation discontinuities (fractures).
- Use site specific **Proof Load Calibration** for proper proof loading of all installed piers.
- Locally designed and fabricated for **Edmonton Conditions**. (**ProGlacial Lake Edmonton Sediments overlying Glacial Tills overlying deep seated Cretaceous Bedrock of weak Mudstone/Sandstone**).
- Designed, fabricated, and installed to Alberta Building Code (Canadian Foundation Engineering Manual 4th Edition) i.e. **Shaft Diameter > 100 mm**.
- **Corrosion Control** by utilizing **Stainless Steel** components (for critical parts) for Internal Piers and **Grout Encasement** for External Piers. Use of corrosion mitigation options extends Lifespan to greater than 100 years (similar to conventional concrete foundations).
- Requires **NO on-site Welding** therefore eliminating fire risk for structure and toxic fumes in side building and within confined work area.
- Designed & Installed by **APEGA Permitted Firm** with Internal Engineering responsible for detailed Pier design, quality control of Pier Fabrication & Installation including as per Alberta Building Code requirements "**A1, A2, B & C" Schedules** (as required).

**Concrete Drilled Pile Caissons (Drilled Shaft)**

A drilled pier is a deep foundation system that is constructed by placing fresh concrete and reinforcing steel in a drilled shaft. This pile is installed by drilling a hole, reinforcing it with a rebar cage dropped down the hole, and then pouring in concrete. For Underpinning, the work area is tight, so the most common method of drilling this hole is with a fabricated A-Frame that leans against the structure and hydraulically drills the hole with an auger.

There are a multitude of disadvantages to this type of pile system. (1) **It is very difficult to attain depths over 25 feet deep due to drilling constraints.** This is often necessary to accommodate the soil issues that are the reason for being there in the first place. (2) **The drilled concrete pile relies on soil friction along the side of the pile to provide capacity**. As discussed earlier, this is a definite problem as the most common reason for Underpinning is due to changes in soil moisture content. These changes alter the soils ability to provide friction along the concrete pile. It is quite common to see failure of this type of pile due to that reason. (3) **The pile system does not generally allow for any lifting mechanism,** so in most cases is just used to attempt stabilization of the foundation. (4) Can **not easily be load tested** so most often is not and assumed loads are used. (5) Is installed ex-centrically and in many instances increases creates vertical displacements.

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**Expanding Foam Resin:**

There is a proprietary process used by a company where a foam resin is injected into the soil below the footing area. This foam is theoretically used to "stabilize and lift" the footing and foundation. It is our opinion that any lift would not be possible without a mechanically method of lifting (hydraulics etc.). Considering that the main reason for foundation settlement is dehydration of expansive clay it is illogical to agree that injection and densifying of the soil at this level will prevent any further settlement if expansive clays continue to dehydrate and shrink. If the main issue were weak base soils or an issue with granular soils or permafrost there might be a positive argument to using this method. We have personally seen too many failures with this method used for foundation stabilization or "lifting" to endorse it.

Years ago Abarent Construction Ltd spent considerable time researching which piling system it should use for Underpinning. Obviously we could have picked any of the methods available, but chose to endorse the method that was most viable for our climate and soil type…The Helical Screw Pile.

**We have evolved a process for all Underpinning Projects:**

1. Engineered Design of the project that includes:
   - For Underpinning - Analyze pattern of cracking and location of cracks
   - Determine proper underpinning pile type
   - Calculate loads of structure and point load areas
   - Calculate allowable spans between piles (This varies on foundation type and size)
   - Obtain soils data from a Soils Bore Hole
   - Have our Engineer design the pile based on required Loads and Soils Data
   - Provide an Engineered Stamped Plan for the project

2. Obtain a Building Permit

3. Excavate and Prep Pile locations

4. Install piles and record installation pressures

5. For Underpinning – Install Underpinning Brackets

6. For Underpinning – Lift Structure (as structure allows) to as close to level as possible

7. Backfill and clean-up project

8. Provide all installation Data to Engineer & Obtain Pile Certification from Engineer

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