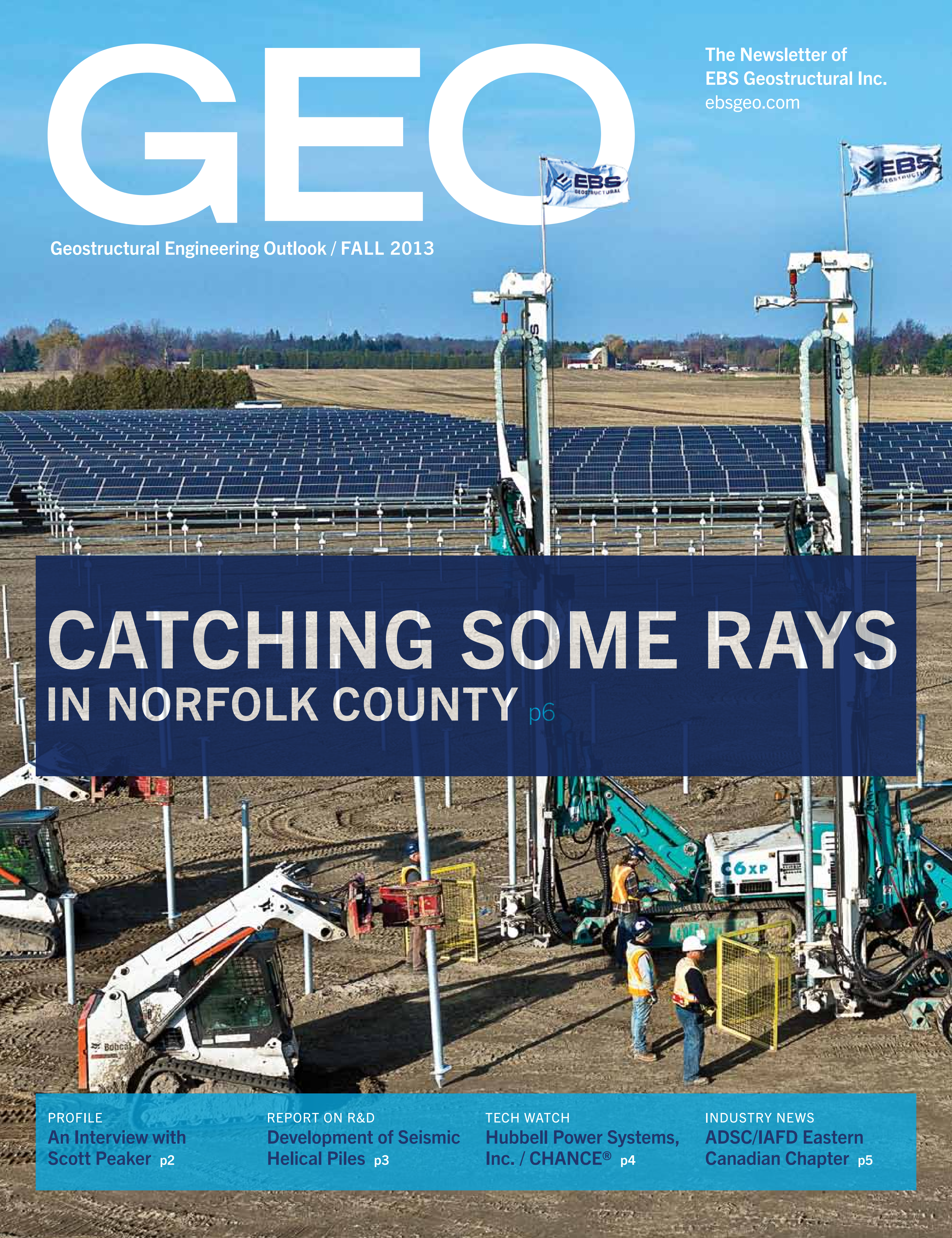
GEO

The Newsletter of
EBS Geostructural Inc.
ebsgeo.com

Geostructural Engineering Outlook / FALL 2013



CATCHING SOME RAYS IN NORFOLK COUNTY p6

PROFILE

Scott Peaker P.ENG

COMPANY
SPL Consultants Ltd
LOCATION
Head Office: Vaughan, Ontario
Branch Office: Cambridge, Ontario
Markham, Ontario
Ottawa, Ontario

Why did you get into the geotechnical field? I followed in my father's footsteps despite his initial attempts to dissuade me from doing so. It started with an interest in geology and grew from there. I also liked the idea of being able to divide your time between the field, lab and office and to have opportunities to travel. At age 16, I was pounding Proctors in Trow's lab in Brampton. At university, several of the professors that I was fortunate enough to have were quite inspirational – such as Cam Kenney and Bob Mitchell in soil mechanics and Evert Hoek in rock mechanics and tunneling.

What trends have you seen in the geotechnical field over your career and what has changed the most? The 80's were mostly tough times economically. There was an unfortunate trend in the 90's being pushed by many consultants to offer 'Risk Management' based consulting services rather than science-based geotechnical engineering. There is nothing wrong with a risk-based approach; however, without having gathered statistically valid amounts of geotechnical data to support the risk-sharing model, the concept is flawed and contractors very justifiably saw this trend as unfairly deflecting underground risk onto them. Fortunately, the industry is correcting itself and there is a very positive trend emerging over the last decade to obtain more geo-data and better quality geo-data. As such, there is a resurgence in fundamental in situ testing and lab testing which is quite refreshing and exciting. Some of this quest for better data is being spurred on by the lead established by current major infrastructure projects, such as the TTC/Metrolinx subway/LRT projects, but it is having positive spillover effects and we are now seeing some of the more enlightened Regional Municipalities demanding similar approaches to investigation, analysis and reporting. Canadian universities have also rekindled their commitment to geotechnical research, having waned considerably in the '80 and early '90s due to lack of funding and poor enrollment in this field, they have now reestablished themselves among the world leaders.

How do you see geotechnical engineering changing in the future? Specialty ground improvement and foundation contractors have evolved and stayed abreast of new technologies at a far more rapid rate than the consulting community. Owners have been reluctant to embrace some of the technologies that are no longer 'emerging' in other markets, they are commonplace. This sets us back competitively as Canadians. A good example is jet grouting which, in the GTA, remains a costly specialty foundation treatment but one which is extremely effective, particularly for base sealing in deep pumping stations and shafts. Fortunately, micropiling has matured and passed the hurdle of being considered 'boutique', gaining acceptance from traditionally conservative structural engineers. Since some of the technology is proprietary, there is a common challenge facing these contractors to effectively market the services and support them with solid soil mechanics theory and case studies. At the same time, consultants need to be more involved in staying current. It is, of course, a delicate balance between 'buying-in' and remaining an impartial testing agency.

Please discuss your father's scholarship at the University of Manitoba? Our family established a graduate scholarship at the University of Manitoba in honour of my late father, Dr. Ken Peaker. This was made possible by generous donations received from friends, colleagues and businesses. Dad undertook his undergrad studies at the University of Manitoba in the late 1950's and that was life changing for him. His graduate scholarship enabled him to study soil mechanics in the UK and to return to Canada with what was quite a new science in those days. This year the award was given to Mehnaz Sadrnourmohamadi, who is a most deserving and gracious PhD candidate in environmental engineering. G

REPORT ON R&D

by Hesham El Nagger P.ENG., B.E.SC., M.E.SC., PH.D.

Development of Seismic Helical Piles

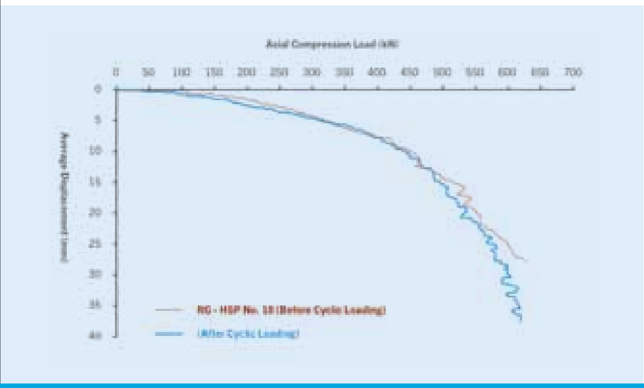


Figure 1: Axial compression load vs. Average displacement of helical pile

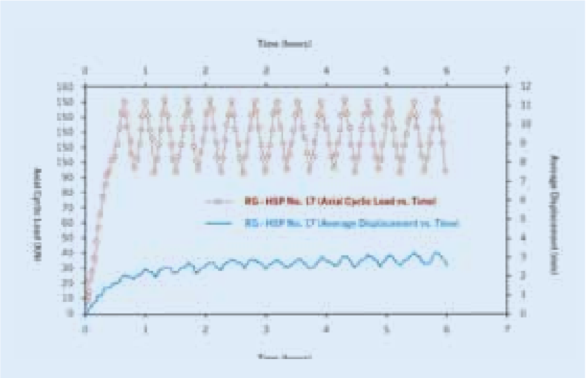


Figure 2: Cyclic loading response of helical pile

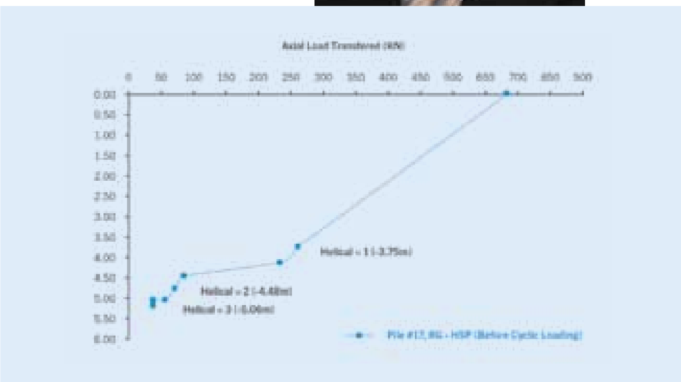


Figure 3: Load transfer to helical plates and grout column

Foundation designers are seeking alternative solutions to ensure safe and economical designs for ever growing structural dynamic loading demands such as environmental (e.g. earthquakes) and manmade (e.g. machines) loads. Working closely with EBS Geostructural, a comprehensive research program was undertaken to investigate the analysis, design and construction of innovative helical pile foundation systems for a variety of infrastructure projects under the action of environmental and gravitational loading. All testing associated with this research was conducted at full-scale. The investigated innovative foundation systems can be used for renewable energy projects and for seismic upgrading of existing and new foundations. This research will be described in further newsletter issues.

The conventional square shaft helical pile transfers its load to the soil through the helical bearing plates. Livneh and El Naggar[1] reported on a comprehensive load testing program involving twenty piles of the Chance SS175 helical foundation system. The load test results showed the applicability of the relationship between the installation torque and helical pile capacity: $Q_{ult} = K_t T$, where Q_{ult}=ultimate capacity [kN], K_t = torque factor [m^{-1}]; T= average. installation torque [kN.m]. This helical system is efficient in resisting vertical static loads, but requires improvements for seismic applications.

Composite FRP-Helical Piles Development of Seismic Helical Piles

Abdelghany and El Naggar[2] and El Sharnouby and El Naggar[3,4] explored two configurations of composite helical piles in order to enhance their seismic performance. Both studies were conducted at the Western environmental test site where soil profiles are primarily cohesive-frictional soil layers. Only the first project is described in this article.

Abdelghany and El Naggar[2] investigated the monotonic and cyclic behavior of helical piles, and explored new configurations for seismic application. It involved conducting more than one hundred full scale field load tests on twenty-three instrumented helical piles installed in cohesive soil and subjected to axial and lateral monotonic and cyclic loading. The test piles included: seven plain helical piles (P-HSP); four grouted helical piles (G-HSPs); eight fiber reinforced polymer grouted helical piles (FRP-G-HSP); and four reinforced grout helical piles (RG-HSPs). Compression axial loading was conducted before and after subjecting the pile to 15 cycles of axial loading to evaluate the pile performance before, during and after a seismic event.

Axial monotonic and cyclic testing

Strain gauges were attached to the shaft above and below the helices and at the mid distance on the shaft between each two helices to evaluate the load transfer mechanism. The load was exerted through a hollow cylinder hydraulic jack connected to a hydraulic pump. The load was recorded through a load cell. The pile head axial displacement was measured through four linear displacement transducers (LDTs). The load cell and LDTs were connected to the data acquisition system. The pile was subjected to an initial compression test, followed by fifteen cycles of axial loading, followed by a final compression test. A special setup was designed and manufactured to apply cyclic loading. The loads were applied in increments of 10% of the expected design load. Examples of the axial loading test results are presented in Figures 1 and 2. Figure 1 shows that the cyclic load did not affect the performance or capacity of the RG-HSP piles. Figure 3 shows that the reinforced grouted shaft carried a significant portion of the load. G

1. Livneh, B. and El Naggar, M.H. 2008. Axial load testing and numerical modeling of square shaft helical piles, Canadian Geotechnical Journal, Vol. 45, No. 8, pp. 1142-1155.

2. Abdelghany, Y. and El Naggar, M.H. 2010. Monotonic and cyclic behavior of helical piles under axial and lateral loading. Proceedings of 5th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, Ed. Prakash, S., San Diego, CA, May 24-29, P. 9.08.

3. El Sharnouby, M.M. and El Naggar, M.H. 2012. Field investigation of axial monotonic and cyclic performance of reinforced helical pulldown micropiles. Canadian Geotechnical Journal, Vol 49, No. 5, pp. 560-573.

4. El Sharnouby, M.M. and El Naggar, M.H. 2012. Axial monotonic and cyclic performance of fibre-reinforced polymer (FRP) – steel fibre–reinforced helical pulldown micropiles (FRP-RHPM). Canadian Geotechnical Journal, Vol. 49, No. 12, pp. 1378-1392.

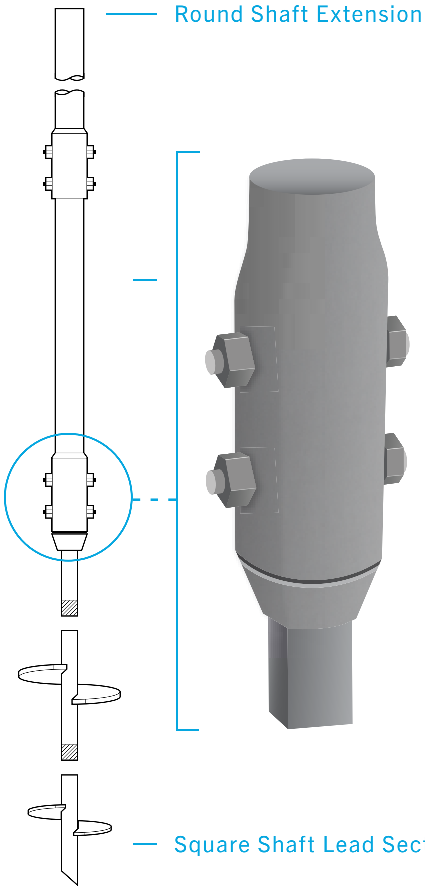
TECH WATCH

by Gary L. Seider P.E.

Hubbell Power Systems, Inc. / CHANCE®
World Leader in Helical Anchors and Piles

In 1833, the helical pile was originally patented as a "screw pile" by English inventor Alexander Mitchell. From this starting point, innovations of the helical anchor/pile have been advanced by both its academic and commercial advocates – including Hubbell Power Systems, Inc (CHANCE). Helical anchors and piles as we know them today were originally developed in the late 1950's by the A.B. Chance Company. Today, CHANCE is the world leader in helical anchor & pile manufacturing, producing several hundred thousand anchors and piles every year. Applications include anchors for tension loads, and deep foundation helical piles for compression loads. Over the past 25 years or so, high capacity helical piles (ultimate capacities greater than 1000 kN) are increasingly being used for commercial applications such as retaining walls and 4-5 storey structures.

Considerable research has been performed by public and private organizations to further advance the design and analysis of helical piles and anchors. Many of the research projects were partially funded or assisted by CHANCE. CHANCE continues to provide financial, material, and engineering support for research ventures related to helical piles. Some new products developed as a result of recent research includes:



TECH WATCH // HELICAL PIERS

Type SS (Square Shaft) to RS (Round Shaft) Transition

This product line allows the Type RS (Round Shaft) helical pile to accept a Type SS (Square Shaft) lead section to provide better penetration into hard/dense soils while keeping the Type RS at the top of the pile to resist buckling in loose/soft soils.

Learn more at www.abchance.com

TECH WATCH // DIGITAL TORQUE INDICATOR

An economical, continuous reading in-line torque indicator

designed to monitor the installation of helical anchors and piles in any soil, weather and lighting conditions. This unit is easy to use, and operates with a single 9-volt battery that will last for days before it needs replacing. It finally solves the long-standing problem of a reliable torque measuring device that can be used every day for an economical price. A wireless remote will be available at the end of the year.

Learn more at: www.abchance.com

INDUSTRY NEWS

by Jason Bindseil B.A., E.T.

ADSC/IAFD Eastern Canadian Chapter

The ADSC (Association of Drilled Shaft Contractors) or more commonly referred to as the International Association of Foundation Drilling was formed in 1972 as a non-profit trade association with goals of bringing specialty contractors, designers, technical affiliates (academics and specialty suppliers) and governmental organizations together to discuss challenges and opportunities within the deep foundation industry.

While the ADSC has always had membership from Canadian companies it has largely been US based. Recently, a regional chapter was formed in Western Canada encompassing the provinces from Manitoba to British Columbia. The "Western Canadian Chapter" has been quite busy over the past year organizing technical conferences, safety seminars and a host of social events. It was clear from the interest and attendance received by the Western Canadian Chapter that something quite similar could be formed in "Eastern Canada". In 2011, the idea of an Eastern Canadian Chapter was brought forth to the Chapter Presidents Council who promptly voted in favour of the new chapter.

Since that time, a group of specialty contractors representing every facet of the drilled shaft industry have united to form the executive board of the Eastern Canadian Chapter. The mission of this chapter echoes the international organizations on a regional level in providing:

- A forum to discuss and promote safety and quality awareness
- Serve as an industry advocate between members and government agencies
- Educational seminars
- Industry specific training sessions
- Networking opportunities

The organization welcomes new members working in the foundation drilling industry, such as specialty subcontractors, manufacturers, suppliers, academics and engineers. For more details or membership registration please send inquiries to *info@adscecc.ca* or visit the website at *www.adscecc.ca*

ADSC
The International Association of Foundation Drilling

ADSC
Eastern Canadian Chapter

ON SITE

Norfolk Solar Project, Norfolk County, Ontario

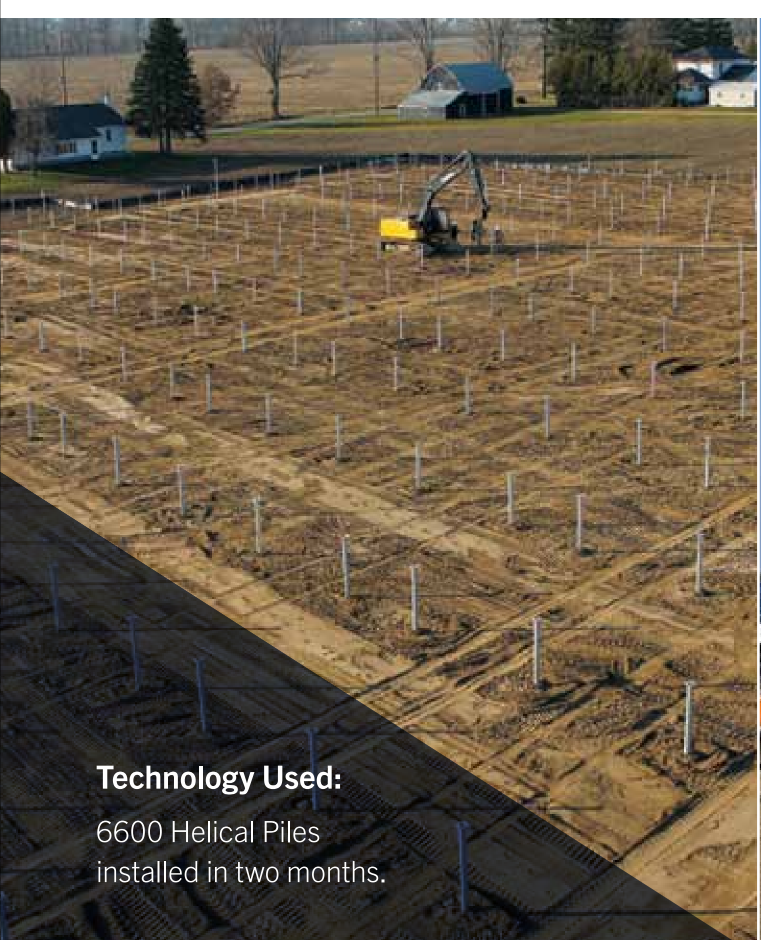
Norfolk County has long been known for its agricultural roots, namely tobacco and ginseng, but in recent years has become a hotspot for eco tourism, fishing, boating, wineries and micro breweries. Located in Southern Ontario, Norfolk County is home to many sand and gravel pits and has a relatively flat topography with occasional rolling hills.

SunEdison, a solar energy services provider had been granted an REA (Renewable Energy Approval) by the Ministry of Environment and by September 2012 secured financing for a 10MW solar project located in Norfolk County, Ontario. SunEdison's EPC contractor, RES Canada was the chosen firm to bring this project to a successful completion. When complete this project will occupy almost 100 acres of land and produce 14 gigawatt hours of electricity per year which is enough to power 1000 homes annually.

After an aggressive testing plan, helical piles were the chosen foundation type over driven piles and tapered screw piles due to their cost, speed of installation and long term performance. Pre-production testing confirmed the 4-1/2" diameter x 3/16" wall central shaft while also confirming that the helix diameter would have to change due to the relative density of the subsoils throughout the site.

It proved beneficial that the pile contractor had the ability to engineer, fabricate and install the piles due to the sites variability. Changes to pile configuration could be made on an "as needed" basis while still maintaining the tight timelines imposed by the owner.

EBS Geostructural was awarded the contract to supply and install 6600 helical piles in two months to support 43,000 solar panels. The helical piles were manufactured at C3 Metalworks and designed by Pretium Engineering (sister companies of EBS). This project was a cumulative effort from design, manufacture and installation of helical piles. G



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A FOUNDATION TO BUILD ON

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