Geotechnical Engineering

I. Introduction

Geotechnical engineering is a specialization within civil engineering that concerned with the analysis, design and construction of foundations, slopes, retaining structures, embankments, tunnels, levees, wharves, landfills and other systems that are made of or are supported by ***soil*** or ***rock***. From a scientific perspective, geotechnical engineering largely involves defining the ***soil's strength*** and ***deformation properties***. It is the study of the behavior of soils under the influence of loading forces and soil-water interactions. This knowledge is applied to the design of ***foundations***, ***retaining walls***, ***earth dams***, ***clay liners***, and ***geosynthetics*** for ***waste containment***. This branch of engineering plays a key role in all civil engineering projects built on or in the ground for the assessment of natural hazards.

Geotechnical engineering or also known as Geotechnics is applied in mostly when planning an infrastructure such as roads and tunnels as well as bridges and buildings. This discipline involves numerical data analysis, evaluating the stability of cliffs and slopes,and assessing load-bearing capacity.

Geotechnical engineering includes specialist fields such as:

1. Soil and Rock Mechanics
2. Geophysics
3. Hydrogeology
4. Geology

The specialism involves using ***scientific methods*** and principles of ***engineering*** to collect and interpret the physical properties of the ground for use in building and construction. Its practical application, e.g. foundation engineering, has come to require a scientific approach.

"**Geotechnics**" – is a term currently used to describe both the ***theoretical*** and ***practical*** application of the discipline.

Recent computational and computer advances are extending our ability to predict the behaviour of soil and soil-water systems under a wide variety of conditions. In recent years, the activities of geotechnical engineers have also involved ***geoenvironmental engineering***.

Geoenvironmental Engineers – design strategies for the clean-up of contaminated soils and groundwater and develop management systems for contaminated sites.

History of Geotechnical Engineering

The history of geotechnical engineering is quite long but at the same time it is interesting. Ancestors in the olden days use soil for an extensive variety of activities from building creation to irrigation and flood control. But during these times the practice of geotechnical engineering was applied by trial and error observational experience in empirical experimentation, basically, it was more of an art than a science.

By the 18th century as civilization advanced further, numerous engineering problems related to building foundations began to emerge.

The Leaning Tower of Pisa which is a tourist attraction today for example presented a very unique challenge at that time. The tower leaned because it is constructed on a soft ground composed mostly of clay, fine sand, and shells without using enough stones to make a strong foundation. This tower plays an important role in history of geotechnical engineering as it serves as an eye-opener for civil engineers to take more specific approach to set up better foundations of buildings with respect to soil design and structure.

. The said incident was so significant that it lead the engineers for more careful process of construction of the Colosseum on 73 A.D at Rome, Italy. It was built over a dried lake, and the Romans had to make sure it was completely drained before laying foundation over the remaining clay bed so it will not bend over like the prior case of building a foundation. Since then, the Romans had the idea of how the state of soil should be observe and analyze before making any step of construction.

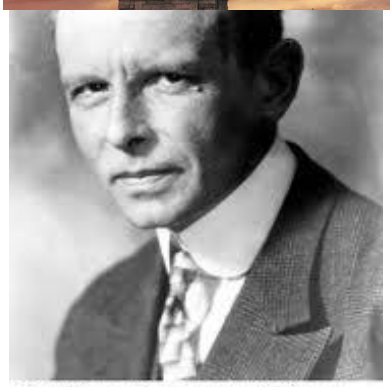
In the late ‘80s, the workforce was challenge by the size of a copper statue with a total height of 305’6”. The Statue of Liberty cannot stand by itself so a big iron framework was put

inside to support the structure and was decided to be placed in a small island where it can stand alone without anyone who will be at risk—at the Liberty Island, Upper New York Bay, in New York City.

Other difficulties related to geotechnical engineering arise continuously, however civil engineers always came up with better solution and help the development of the field to further progress.

As time pass by, geotechnical engineering also developed. Builders began taking a more scientifically based approach, including detailed examination of subsurface materials.

From early 1700s to the early 1900s scientists such as Coulomb, Darcy, Rankine, Boussinesq, Mohr and Atterberg published fundamental theories on soil mechanics and water flow through soil. Several prominent organizations and societies were formed in the early 1900s to advance this field of engineering. Particular recognition is given to Karl von Terzaghi who is considered as the "father of soil mechanics and geotechnical engineering" because of his classic book Erdbaumechanik (Soil Mechanics) published in 1925. His book literally revolutionized the field of geotechnical engineering.



Karl Terzaghi: Founder of Modern Geotechnology. Photo courtesy of The MIT Museum

He developed the principle of effective stress in soils, the framework for the bearing capacity of foundations theory, and the theory for predicting the rate of settlement due to consolidation of clayey soils.

In 1925, he established the country's first academic program in Soil Mechanics at the Massachusetts Institute of Technology (MIT);

In 1930, his work had led to the appointment of a Special Committee on Earthworks and Foundations by the American Society of Civil Engineers (ASCE).

International Society for Soil Mechanics and Geotechnical Engineering

International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) is a society representing Engineers Academics and Contractors all over the world that actively participate in geotechnical engineering. The International Society had its origins in the First International Conference on Soil Mechanics and Foundation Engineering held in Harvard in 1936. A total of 206 delegates attended from 20 countries. In order to ensure continuation of this very successful initiative, an Executive Committee was set up with Karl Terzaghi as President and Arthur Casagrande as Secretary. In 1997, Council approved a change in name to the International Society for Soil Mechanics and Geotechnical Engineering to reflect more accurately the activities of the Society. Then it passed its great time expanding itself round the globe. The aim of society is the promotion of international co-operation amongst engineers and scientists for the advancement and expansion of knowledge in the field of geotechnics.

ADVANTAGES AND DISADVANTAGES OF GEOTECHNICAL ENGINEERING

Advantages of Geotechnical engineering

1. Geo engineering could be very potent.

By adding higher levels of sulfur dioxide directly into the atmosphere, it might be entirely possible to offset all of the warming effects that happen because of carbon dioxide. The efforts would create aerosols that would reflect sunlight straight back into space instead of concentrating the sun's rays onto the planet below.

2. It could be extremely affordable.

Under some theories, geo engineering could be accomplished through the use of a simple 2 inch hose that was stretched into the atmosphere. By pumping the sulfur dioxide into the air, it would then become very feasible to stop the effects of global warming before they can continue to create chaos within a regional climate.

3. We have proof that geo engineering works.

The reason why this type of plan to stop global warming is so exciting is because we have documented evidence that it will work. There is historical evidence that shows large volcanic

eruptions have been able to stop global warming cycles in the past. The distribution of sulfur dioxide into the atmosphere simply replicates the effects that a volcano would create naturally.

Disadvantages of Geotechnical engineering

1. Geoengineering could change weather patterns dramatically.

Any time a scientific proposal to limit the amount of sunshine is brought up, the natural consequence of taking such an action would be to reduce the amount of rainfall that occurs. We need rain because it is nature's natural water filter. If we don't receive it, then it would be difficult to raise crops and food resources could become scarce.

2. It won't solve all our problems.

One of the biggest issues that we have today is ocean acidification. Geoengineering does not solve this problem whatsoever. We would still be needing to deal with droughts and famines as they occur, and because there would be weather changes associated with the inclusion of extra sulfur dioxide, we might actually be dealing with more disastrous effects from the shift climates then from the immediate issues of global warming.

3. It only cools the equatorial regions effectively.

In order to stop the melting of the ice at the North Pole and South Pole, the planet would have to be cooled down enough that it would meet pre-industrial levels of warmth to stop the ice sheets at the Polar Regions from melting. Because extra levels of sulfur dioxide would be required to accomplish this, it would also create a sky that looked whiter than it did blue.

If we are in desperate shape, then geo engineering could provide us with the options we need to save our civilization. By weighing the pros and cons of this alternative, we can decide together if it really is the right course of action to take.

II. Education

WHAT ARE THE QUALIFICATIONS NEEDED TO BECOME A GEOTECHNICAL ENGINEER?

The qualifications needed to become a geotechnical engineer include at least a ***bachelor's degree in civil engineering or geotechnical engineering.*** A program accredited by **ABET** is needed in order to gain ***licensure***, which is required to work as a ***professional engineer (PE)***. A few universities offer graduate degrees in geotechnical engineering.

Wih this profession, **relevant subjects** may include:

1. Engineering Geology
2. Geology
3. Geophysics
4. Geotechnology
5. Mineral/Mining Engineering

RECOMMENDED COURSES In order to achieve a specialization in the area of Geotechnical Engineering at the undergraduate level, the following courses are:	
Strongly recommended:	**Recommended:**
CIVE 416 Geotechnical Engineering (3 Credits)	CIVE 446 Construction Engineering (3 Credits)
CIVE 451 Geoenvironmental Engineering (3 Credits)	CIVE 520 Groundwater Hydrology (3 Credits)
	CIVE 584 Mechanics of Groundwater Flow (3 Credits)
	MIME 322 Rock Fragmentation (3 Credits)
	MIME 520 Stability of Rock Slopes (3 Credits)

Licensing And Training (In The Philippines):

To become a ***Licensed Civil Engineer in the Philippines***, a graduate of Civil Engineering needs to pass the ***Civil Engineering Licensure Examination***. The examination is conducted by the Board of Civil Engineering under the supervision of the ***Professional Regulations Commission (PRC).***

Aside to the education, a geotechnical engineer must also have a strong understanding to the other related fields, including ***construction***, ***math***, and several ***natural sciences***, especially

geology. In addition from the varied knowledge base, you must be organized, have excellent communication skills, and be able to self-manage to fulfill your responsibilities.

WHAT IS A GEOTECHNICAL ENGINEER?

GEOTECHNICAL ENGINEERS – are specialists that use engineering principles and applications to research, investigate, assess construction sites, conduct lab tests, create design for structures, supervise construction and present reports. Their ultimate goal is to ensure the project safe and sustainable to the structure's stability against earthquakes, mud slides and other natural events.

– there skills are used for drilling wells, constructing production and storage facilities, transporting petroleum products and examining ground water flow.

RESPONSIBILITIES OF A GEOTECHNICAL ENGINEER

- Build and maintain relationships with clients and other professionals involved in the site, throughout each project
- Maintain safety standards on site
- Be mindful of cost implications when you make recommendations

ROLES OF GEOTECHNICAL ENGINEER

- research and study soil to evaluate its suitability for foundations
- investigate and assess construction sites, conduct lab tests, create designs for structures, supervise construction, and write and present reports
- work on such projects as designing tunnels, roadways, retaining walls, and earth dams, as well as helping to create strategies for the clean-up and management of contaminated sites
- they are assigned in the collection of soil samples from the project's intended site, using bores and test pits.
- determine whether issues like erosion, settlement and slope will pose a safety risk to the proposed project

- required to analyse the results of subsurface investigations and field tests with dedicated software
- required to spend most of their time in the field - and in analysis laboratories. The job involves lots of travel and plenty of strict deadlines - and work in most weather conditions

SOME SEMINARS ABOUT GEOTECHNICAL ENGINEERING

- Geotechnical Engineering Seminar 2019 – September 23, 2019 at Hotel Cititel, Penang, Malaysia
- International Conferences (numerical methods, computational mechanics, artificial ground freezing, wave equation analysis, pressure grouting & etc.)

SOME COMPANIES THAT HIRE GEOTECHNICAL ENGINEERS

- Brown and Greenfield Inc.
- JJ3 Trading group
- Advanced Geotechnical Engineering Services
- AMH Philippines

III. Job Demands and Environment of Geotechnical Engineering

IMPORTANCE OF GEOTECHNICAL ENGINEERING

Geotechnical engineers are responsible for evaluating subsurface and soil conditions and materials, using the principles of soil and rock mechanics. They are commonly appointed as consultants on construction projects. Engineers also examine environmental issues such as flood plains and water tables.

The studies of the geological material properties on a construction site are important to allow design and construction of stable structures that:

- do not settle,
- deform or crack and
- do not fall down due to foundation failure.

Is it in-demand in the country or internationally?

Geotechnical engineers are in demand. According to the Bureau of Labor Statistics, civil engineer employment is projected to grow 11% over the next decade or so, which is higher than the average job growth rate. All structures require strong foundations, from bridges to buildings to dams. Therefore, geotechnical engineers are always in demand as long as new construction projects are being built.

Jobs open for the course

A geo-technical engineer has an important job role in analyzing soil, rock, groundwater, and other earth materials prior to major construction projects. This analysis can help determine what materials must be used in the structure's foundation or overall design, or whether the project needs additional measures to ensure it is safe.

Thus, there are several job opportunities that a Geotechnical Engineer can get locally, and even internationally given the fact that there are countless projects requiring the aid of a Geotechnical Engineer in order to ensure the safety of different infrastructure in different type of environment.

Geotechnical engineers perform the following functions within the framework of the following jobs:

Geotechnical or Geological Engineers (General)

- provide analysis and mapping of technical results obtained from seismic surveys, and investigate subsurface conditions and materials to determine their properties and risks

Geotechnical or Geological Engineer (Oil Sands Projects)

- design open pit walls, mine waste dumps and dam structures used in oil sands mining, and analyze slope stability, seepage and hydraulic separation on dam structures.

Hydrogeological Engineer

- provide design and analysis of ponds containing discarded oil sands materials, water extraction from soil and sand, and steam injection into wells; and evaluate underground

water layers trapped in rocks (aquifers). They also provide advice on environmental restoration.

Reservoir Geomechanics Engineer (Oil & Gas Operations)

- analyze the strength of soils, drill hole stability, stress constraint, permeability of rock formations and the degree of trapped hydrocarbons in underground reservoirs

Geomechanics Engineers (Marine Operations)

- analyze the relationship between physical structures and marine geology, anchoring systems, sediment erosion, slope stability, and foundations for offshore and coastal structures

Information about International Society for Soil Mechanics and Geotechnical Engineering

FOUNDED: 1936 Cambridge MA USA

The International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) is an international professional association, presently based in London, representing engineers, academics and contractors involved in geotechnical engineering. It is a federation of 89 member societies representing 90 countries around the world, which together give it a total of some 19,000 individual members. There are also 38 corporate associates from industry. The current ISSMGE President is Professor Charles W.W. Ng of The Hong Kong University of Science and Technology.

ACTIVITIES:

The ISSMGE organizes conferences on subjects including deep foundations, earthquake engineering and underground construction. Its main events continue to be the quadrennial International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE), plus five quadrennial regional conferences, Young Geotechnical Engineers' Conferences, and specialist international conferences, symposia and workshops.

In addition to a bimonthly bulletin and various technical committee reports, the society publishes an official scientific journal in collaboration with Geoengineer.org, the International Journal of Geo-engineering Case Histories. This is a peer-reviewed online journal that presents

reports of observations and data collected in the practice of geotechnical engineering, earthquake engineering, environmental geotechnics, and engineering geology.

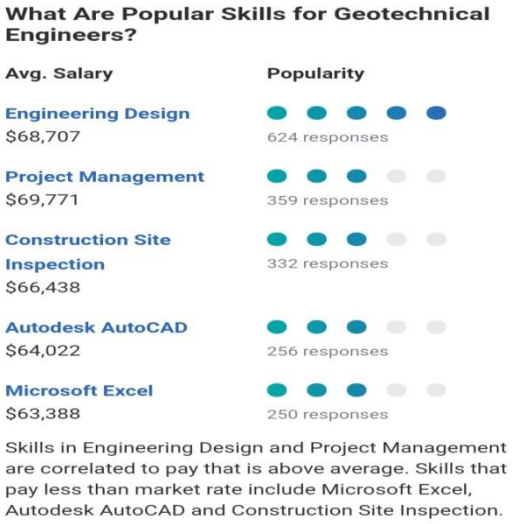
AIMS:

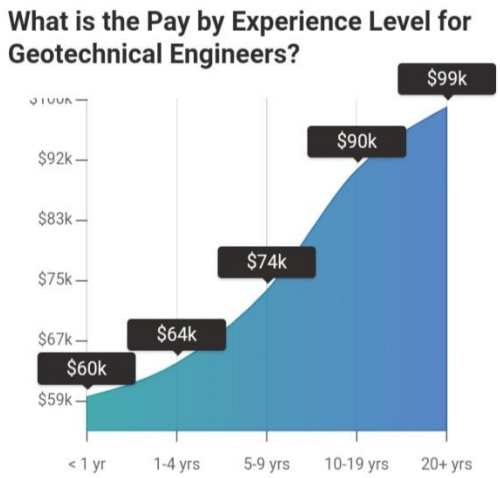
The aim of the International Society is the promotion of international co-operation amongst engineers and scientists for the advancement and dissemination of knowledge in the field of geotechnics, and its engineering and environmental applications. Benefits of membership include:

- possibility to submit papers to many conferences and symposia
- lower conference registration fees
- possibility of membership of one the many technical committees working on specific topics
- access to work of ISSMGE in various fields of activity, including Education, Communications, Technology Transfer
- opportunities to demonstrate leadership in Technical Committee, conference and other activities
- opportunities to build lasting world-wide relationships
- a clear demonstration of interest and professionalism in the field of Geotechnics

- Most of the Geotechnical Engineer are from the companies Terracon Consultants, Inc., Terracon and Aecom Corporation. Reported salaries are highest at Haley & Aldrich, Inc.

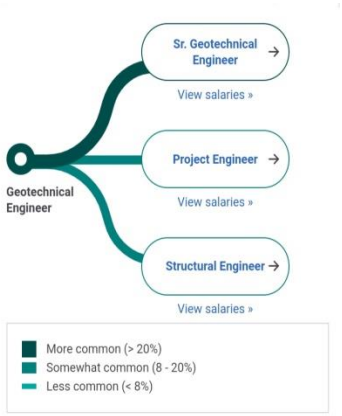
where the average pay is $87,500. Other companies that offer high salaries for this role include WSP Global Inc. and Froehling and Robertson Inc., earning around $86,000 and $77,870, respectively. Terracon Consultants, Inc. pays the lowest at around $63,378. Stantec Consulting Ltd. and Terracon also pay on the lower end of the scale, paying $63,875 and $64,547.





- Skills in Engineering Design and Project Management are correlated to pay that is above average. Skills that pay less than market rate include Microsoft Excel, Autodesk AutoCAD and Construction Site Inspection.
- An entry-level Geotechnical Engineer with less than 1 year experience can expect to earn an average total compensation (includes tips, bonus, and overtime pay) of $59,545 based on 153 salaries. An early career Geotechnical Engineer with 1-4 years of experience earns

an average total compensation of $64,100 based on 584 salaries. A mid-career Geotechnical Engineer with 5-9 years of experience earns an average total compensation of $73,967 based on 273 salaries. An experienced Geotechnical Engineer with 10-19 years of experience earns an average total compensation of $90,254 based on 117 salaries. In their late career (20 years and higher), employees earn an average total compensation of $98,760.



IV. Projects Involving Geotechnical Engineering

Some projects that involve geotechnical engineering are the following:

Four Seasons Hotel & Legg Mason, Baltimore

MD Geo- Technology Associates, INC.(GTA) consist a group of geotechnical and environmental consultants which provided geotechnical, environmental assessments and

permitting, geohydrological, and construction phase testing and consultation services for the $580 million, Four Seasons Hotel and Legg Mason Office complex in Baltimore's Inner Harbor.

The foundation, slurry wall, under-drain system, and mat foundations are constructed for this high-rise hotel/condominium and office building complex with a 22-story hotel and condominium tower encompassing 455,000 SF (with capacity of construction to 45 stories), and a 26-story, 600,000-SF office tower located directly adjacent to the harbor waterfront.

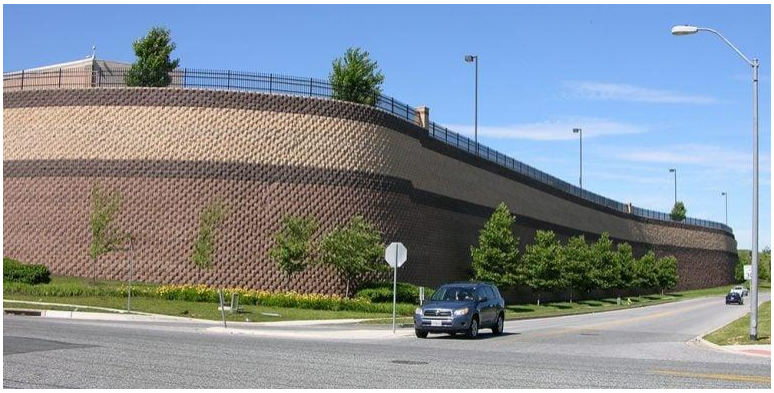
Explorations included borings, monitoring wells, seismic Cone Penetrating Soundings, and packer in-situ permeability tests. GTA performed geotechnical evaluations and analysis and developed recommendations for the design and construction of mat foundations. They also assisted the design team in selecting a design that relieves the hydrostatic pressure under the mat that eliminated the need for costly tie-downs. GTA also prepared a geohydrologic model for the site and performed analysis using "ModFlow" to assess the seepage into the excavations and under the foundations after construction. GTA designed and prepared plans and specifications for an underdrain system to control and collect groundwater below the mat foundation set about 50 feet below the groundwater levels. GTA prepared specifications for construction dewatering. GTA monitoring displacements of adjacent high-rise buildings during deep excavation and construction of the underground parking garage. GTA monitored settlement and inclination of the buildings using instrumented survey techniques. Also monitored inclination of the parking structures slurry walls using inclinometers. GTA performed Phase I and II Environmental Site Assessments during the design phase of the project. An environmental management plan was prepared to provide guidance and requirements for monitoring and disposal of contaminated materials. GTA provided construction phase testing and observation for structural slurry wall, tie-backs, mat foundations, and underdrain system.

During the construction of slurry wall, chromium-contaminated groundwater was encountered. GTA provided coordination with regulatory agencies and oversight for permitting, collection, treatment, and disposal of about 1.5 million gallons of contaminated water and sediments. GTA provided design, specification, and installation details for an instrumentation program to assess movement of the slurry wall and surrounding structures and pore pressures changes outside the slurry wall.

The monitoring also included sampling of groundwater and sediments to assess contamination. GTA's services allowed the client to identify and implement cost-effective

solutions for geotechnical, environmental, and groundwater control issues. GTA's prompt response/recommendations to troubleshoot and resolve issues during construction allowed the project to proceed without delays.

Retaining Wall at Box Hill, Harford County



MD GTA designed a modular block retaining wall to support the proposed 140,000 +/- square foot Wegmans grocery store at the Boulevard at Box Hill as well as its associated pavement areas and subsurface utilities. In conjunction with our design, GTA performed a geotechnical exploration within the area of the retaining wall to determine the subsurface conditions within the zone of influence beneath the wall. The design included both internal and global stability analyses to assess the long-term stability of the fill and underlying Potomac Clay deposit.

GTA also provided construction observation and testing services during construction of the wall which required over 40,300 square feet of Keystone Standard 21.5-inch block to achieve its final dimensions of over 1,340 feet long with a maximum exposed height of over 40 feet. The drainage pipes at the base of the wall and behind the reinforced fill are interconnected and drain beneath the wall directly into the public storm drain system. The wall backfill consisted of native sand and gravel and was reinforced with Mirafi geogrid. The structural components of the wall took less than two months to construct.

Wilmington Country Club Water Impoundment Structure, Wilmington

DE GTA provided geotechnical engineering for the 21-million-gallon water impoundment structure at Wilmington Country Club. Services included subsurface exploration and well installation, groundwater monitoring, slope stability and seepage analysis, and earthwork recommendations during design and review of the earthwork and engineering consultation during construction.

Lancaster Newspaper Parking Structure, Lancaster

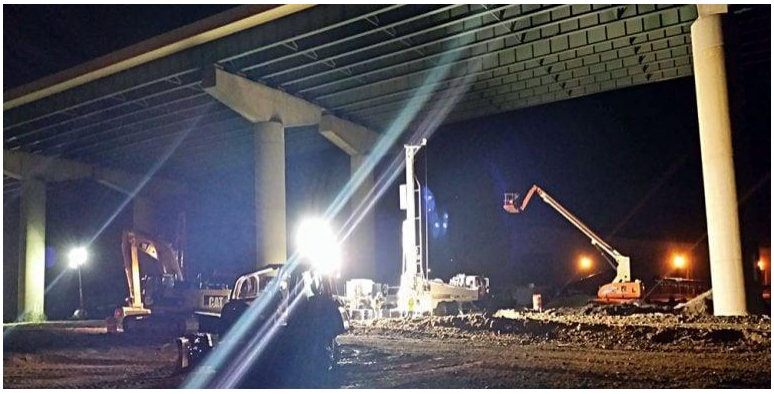
PA GTA provided geotechnical services for the construction of a six-level precast concrete parking structure in Lancaster, Pennsylvania. The garage required excavations up to 17 feet in depth within an urban environment with existing structures on two sides of the proposed garage.

Based on the original design, the proposed foundations could not be economically installed using conventional shoring systems.

GTA designed a permanent shoring system that would also function as a permanent pressure relief wall. This allowed the proposed footings to be redesigned and conventional shoring systems to be economically installed. For the permanent pressure relief wall, GTA designed a soldier pile wall with shotcrete lagging and a soil nail wall with shotcrete facing. GTA provided observation and testing during construction, including test nail evaluation. GTA designed the micropile system to support the proposed garage footings on the underlying limestone bedrock.

Two types of micropiles, consisting of 7-inch and 9 5/8-inch diameter, were designed. GTA provided observation and testing for the test pile. GTA also designed an underpinning system to support an adjacent structure. The underpinning design used a pit system that extended to depths of up to 7 feet.

I-495 Emergency Bridge Repairs, Wilmington



DE GTA provided emergency response and corrective action services including subsurface exploration and geotechnical engineering services to repair BR1-183 on I-495 over Christina River in June 2014 through its open-ended contract with Walton Corporation. GTA's engineers and scientists worked diligently 24/7 for 12 days in order to obtain the necessary subsurface exploration for the design team.

Working conditions were tight as contractors worked to remove a soil stockpile thought to cause the bridge's foundation to tilt and rotate, subsequently closing the bridge for almost four months. Given the limited access underneath the bridge, it was imperative that the subsurface exploration and instrumentation be installed prior to the foundation contractor mobilizing to the

site. Staff engineers performed borehole logging for six Standard Penetration Test borings and approximately 120 feet of rock coring performed by Walton Corporation.

The elevated pore pressures at the project site made for difficult drilling conditions. GTA performed 12 Cone Penetrometer Test soundings along with pore pressure dissipation tests, and GTA also monitored pore pressure through monitoring wells, pressure transducers and vibrating wire piezometers installed during those days. GTA oversaw the installation of that instrumentation, as well as two in-place inclinometers with automated readings.

The instrumentation was monitored remotely using a data acquisition system. The instruments were monitored for approximately 12 months by GTA, who performed data reduction and provided Delaware Department of Transportation (DelDOT) with a monthly summary. GTA supplemented consolidation testing performed by DelDOT's in-house laboratory by performing unit weights and loss on ignition tests of undisturbed samples, 14 Unconsolidated Undrained Tests and 14 compression tests on rock.

Zayed National Museum in Abu Dhabi, UAE

The Zayed National Museum will be the centrepiece of the Saadiyat Island Cultural District and will showcase the history, culture and, more recently, the social and economic transformation of the Emirates. Architecturally, the aim has been to combine a highly efficient, contemporary form with elements of traditional Arabic design and hospitality to create a museum that is

sustainable, welcoming and culturally of its place. Celebrating Sheikh Zayed's legacy and love of nature, the museum is set within a landscaped garden, based on a timeline of his life.

The Tran Thi Ly bridge in Da Nang, Vietnam

The Nguyễn Văn Trỗi–Trần Thị Lý Bridge is a bridge spanning the Hàn River in the city of Đà Nẵng, Vietnam. The new bridge replaces two older bridges named after Nguyễn Văn Trỗi and Trần Thị Lý. Wikipedia Address: 02-09 Duy Tân, Hòa Thuận Đông, Hải Châu, Đà Nẵng 550000, Vietnam Width: 36 m Location: Da Nang Body of water: Hàn River

Manchester Metrolink, in Manchester, United Kingdom

Manchester Metrolink is England's first modern street-operating light rail system. It includes seven lines that serve the towns of Bury, Altrincham, Eccles, Ashton-under-Lyne, East Didsbury, Manchester Airport, and Rochdale, meeting at Manchester city centre. Metrolink incorporates the features of heavy rail and trams.

First Street Tunnel, in Washington DC, United States

The First Street Tunnel is a two-track, soft-earth tunnel built between 1904 and 1906 by the Washington Terminal Company to serve as the southern approach to Union Station in Washington, D.C. Wikipedia Tunnel clearance: 17 ft (5.18 m) Owner: Amtrak Opened: 1906 No. of tracks: 2 single-track tubes Track gauge: 1,435 mm (4 ft 8 1⁄2 in) standard gauge Constructed: 1904-1906 Length: 4,033 ft (1,229 m).

City Line in Stockholm, Sweden

The Stockholm City Line is a commuter railway tunnel beneath central Stockholm in Sweden which is used by the Stockholm Commuter Rail. The line is 7.4 kilometres long, double track and electrified. Wikipedia Location: Stockholm, Sweden Line length: 7.4 km (4.6 mi) Stations: 3 Rolling stock: X60/X60B System: Stockholm commuter rail Operating speed: 90 km/h (56 mph) Owner: Swedish Transport Administration.

Gotthard Base Tunnel

At 57 kilometres, the Gotthard Base Tunnel (GBT) is the longest railway tunnel in the world and represents the centrepiece of the New Rail Link through the Alps (NRLA). It embodies Swiss values such as innovation, precision and reliability. The Gotthard Base Tunnel provides a quicker, more reliable link between north and south for both people and goods. SBB is proud to be operating the longest railway tunnel in the world.

Faster, more frequent and more convenient services as well as new and modernised rolling stock will considerably increase the transport quality on the north-south axis. Customers will also benefit from more seats. The improvements will take effect gradually from the end of 2016 and provide their full benefit from the end of 2020. At the same time, SBB will actively market the Gotthard region and the mountain route. In total, SBB expects demand for passenger services to almost double by 2025, with passenger numbers increasing from the current figure of 9,000 people to approximately 15,000 people per day. More new trains will be provided in order to meet this increase in passenger demand.

Águas Livres Aqueduct

The Águas Livres Aqueduct, is a baroque architectural infrastructure commissioned by King Dom João V, which was built between 1731 and 1799,. It is a hydraulic structure that stretches over 36 miles, built of cut stone quarried in the Lisbon area, together with limestone masonry.

It was the last great classical aqueduct to be built all over the world, constituting a system for the capture and transport of water, which passes through five separate municipalities in Portugal: Amadora, Lisboa, Odivelas, Oeiras and Sintra. It begins in a rural area, in the municipality of Sintra, where it cohabits with cultivated fields and pine groves, and, throughout its length, it crosses urban areas, surrounded by buildings and public roads. In the municipality of Amadora, it runs parallel to the railway line from Sintra to Lisbon.

AGES is ably managed by the conjugal partnership of Richard C. Tan and Janet Y. Veloso. The former is a first placer in the May 1980 Civil Engineering Board Examination and a consistent University Scholar during his post-graduate studies at the University of the Philippines. He has 30 solid years of experience as a practicing geotechnical and pile testing engineer, and had likewise spent the last twenty-five years either as the company's project manager or geotechnical consultant for important geotechnical works, and in conducting pile testing services. He has been likewise involved, directly or indirectly, with the Department of Public Works and HIghways (DPWH) as a geotechnical consultant in its various projects. These are some of their newly proposed projects.

British Embassy-Manila located at Mckinley Hill Village, Taguig

Client: Mace Limited, LONDON

Scope of Work: Foundation investigation

Sakamoto Plant Expansion Project located at Bauan, Batangas

Client: BAUER FOUNDATION PHILIPPINES, INC.

Scope of Work: High Strain Dynamic Testing

Iloilo Airport

Client: Trevi FOUNDATIONS PHILIPPINES INC.

Scope of Work: High Strain Dynamic Testing, Static Testing, Ultrasonic Cross-hole Logging Test

Hanjin Philippines Subic Shop Facility located at Subic Bay Freeport Zone, SBMA

Client: LC BUILDERS & DEVELOPMENT, INC.

Scope of Work: High Strain Dynamic Testing, Static Load Testing

Panay Powerplant Project located at Brgy. Ingore, Lapaz, Iloilo City

Client: PANAY POWERPLANT CORPORATION

Scope of Work: High Strain Dynamic Testing

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