

Online Resources Utilization in Geotechnical Engineering Laboratory for Undergraduate Civil Engineering Students

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ABSTRACT

Conducting geotechnical engineering laboratory with practical excises in undergraduate civil engineering program is always a challenge for instructors. These difficulties are caused by class time limit, budget deficiency, students' interest and appropriate degree of facts which simulate in situ engineering projects. Furthermore, the Accreditation Board for Engineering and Technology (ABET) accreditation requires civil engineering program outcomes to be recognized for modern tools necessary for civil engineering practice particularly in the area of geotechnical engineering. Utilizing online resources is a convenient strategy to be a non-conventional teaching method which can be introduced in geotechnical engineering laboratory with up-to-date information. This study has provided several valuable online resources for varied geotechnical engineering categories including Google Earth (site overview, land use, and transportation access), USGS Survey website (seismic hazard evaluation, geology condition, and topography), FEMA Flood map service (flood hazard zone), and USDA Soil Survey website (soil physical and mechanical properties down to 5 ft deep, groundwater depth, and etc.). One laboratory assignment which has been adopted by the department of civil engineering at West Virginia University Institute of Technology (WVU TECH) in Montgomery, WV is presented in this paper to demonstrate the application of online resources in geotechnical engineering laboratory exercise. Student class survey with feedbacks, faculty self-assessment and ABET learning outcomes contribution are also enclosed in the final discussion.

Introduction

In the 21st century, Internet effects our daily life from fundamental infrastructures to social lives. Internet impacts even more than ever on engineering program curriculums in higher education. Geotechnical engineering is one expertise of traditional civil engineering industry but it is not a single area of our civilization that has not been touched by the fast growing cyber technology and widespread online resources. Modern college students are so attracted to the cyber world and use Internet as their first knowledge source instead of textbooks, journals, library and even consulting from their instructors. Taking advantage of cyber technology, the pace at which

Internet is transforming geotechnical engineering knowledge from industry professionals, government agencies and research institutes to higher education classroom is breathtaking. [1]

ABET's Engineering Criteria 2013-2014 significantly emphasis that civil engineering programs must prepare graduates so that they can successfully conduct civil engineering experiments and analyze and interpret the resulting data enter. Civil engineering graduates must be able to continue practice of engineering or process in more than one civil engineering context. These criteria must be achieved in civil engineering programs in order to satisfy ABET accreditation.[2] Most civil engineering undergraduate programs teach basic principles of soil mechanics as obligatory course and other relative subjects such as foundation design, slope stability or pile foundation for elective courses. In fundamental soil mechanics course, instructors have to cover basic principles, formulas, and theories in limit three credit hours basis without much exposure to applications with project based learning model.[8] Furthermore, geotechnical engineering laboratory which is subsidiary of fundamental soil mechanics course in undergraduate civil engineering program which contains hands-on experiments to determine soil physical and mechanical properties. This laboratory is normally scheduled for three hours laboratory work within one credit throughout the semester. Unfortunately, these experiments are usually being used to strengthen lecture theories over the practical application in engineering practice. Since the test results are predictable, hypothesized or slighting by instructor, students lose interest easily in the laboratory work and begin to be weary of writing regular laboratory reports.

The project based model is an effective strategy to be adopted in geotechnical engineering laboratory. One single practical project can easily combine several individual soil tests to be used for geotechnical analysis. Students learn not only the individual hands-on soil tests but also the correlation between principle theories, field issues, practical consideration and engineering judgment. In addition, the online resources can sufficiently intensify the contents of students' achievements and learning outcomes. One student laboratory project which has been practiced in the department of civil engineering at West Virginia University Institute of Technology (WVU TECH) in Montgomery campus will be presented here as an example to demonstrate how the online resources getting involved in geotechnical engineering laboratory.

Online Resources for Geotechnical Engineering Laboratory

There are multiple internet resources which can be applied in lecturing geotechnical engineering courses including giant commercial companies, state department of highway (DOTs), military engineering documents, and federal government agencies. The following subjects are some significant Internet resources which are popular, free and open to public around the world.

Google Earth

Google Earth (<https://www.google.com/earth/>) is a web-based visual geographical database product. Google Earth is one of the most popular internet resources which is widely to be used

for ground surface inspection via its free public access to satellite images, aerial photographs and street view visions. Google Earth is one of the best tools which can display the past and latest imageries. Unlike traditional topographical maps only presenting elevation contour lines in 2D, Google Earth provides 3D elevation view with overlap satellite images in its digital elevation model. This 3D model contributes a substantial supplement for students to visualize the job site situations (hill slope, potential flooding zone, earth work and street system and existing or past structures, etc.) without traveling to the project location. Furthermore, users can exam the current and past images to track down the rapid natural or human factor changing in topography and drainage systems, coastal erosion, dam level fluctuations, flood lines and land use history.[7]

U.S. Geological Survey

The U.S. Geological Survey (USGS) is a federal government agency that provides up to date information on natural hazards, natural resources, climate and land-use change. USGS web site (<http://www.usgs.gov/>) is a giant database which contains topographical maps (current and past), geologic maps, satellite images, and aerial photographs. These data resources are all free to be downloaded and open to public all over the world. Students in geotechnical engineering laboratory can be benefited from the mentioned fundamental ground database to study the project job site including geologic features, distances from major fault lines, land-use planning and avoiding adverse subsurface conditions due to fracture bedrocks or geological sensitivity. USGS also provides earthquake hazard database which includes seismic hazard maps displaying earthquake ground motions for various probability levels across the United States. Peak ground acceleration maps are applied in seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy. In addition, USGS supplies soil type database, soil liquefaction hazard maps and seismic hazard maps in some high risk/sensitive earthquake hazard urban areas along the Pacific coast. The above-mentioned USGS online resources can be used by students in project based exercises to evaluate earthquake hazard and risk assessments.[9]

FEMA Flood Map Service

The Federal Emergency Management Agency (FEMA) is an emergency respond organization under the U.S. Department of Homeland Security. FEMA Flood Map Service Center website (<http://msc.fema.gov/portal>) is an official public source for flood hazard information produced in support of the National Flood Insurance Program. Students can find official flood map, access a range of other flood hazard products, and take advantage of tools for better understanding flood risk in their studied project sites. The development inside the flood zone must consider a number of factors. Students will learn the influences of design loads (hydrostatic loads, wave loads), geotechnical considerations (erosion, stress change) and economic impactions.[3]

USDA Soil Survey

The Natural Resources Conservation Service web site (<http://websoilsurvey.sc.egov.usda.gov/>) is under the U. S. Department of Agriculture (USDA). USDA soil survey database covers 95% of

the entire continental 48 states and offers access to the largest natural resource information system. The soil survey web site provides multiple and comprehensive soil properties.^[6] Some of the functions performed by USDA web soil survey which are very useful info for students to study their geotechnical laboratory projects which are listed here:

- a. Soil Taxonomy Classification (Based on six categories of the National Cooperative Soil Survey, NCSS)
- b. Corrosion of steel (Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel)
- c. Dwellings rate (Soil properties affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs)
- d. Shallow excavation rate (Soil properties influence the ease of digging and the resistance to sloughing to a depth of 5 feet)
- e. Erosion hazard rate (The rating indicates the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface)
- f. Soil chemical Properties (Calcium, Sodium and pH)
- g. Soil mechanical properties (Liquid limit, Plasticity index, hydraulic conductivity)
- h. Soil engineering classification (USDA texture, AASHTO classification and Unified soil classification)
- i. Soil particle sizes (Percentage passing No.4, No.10, No.40 and No.200 sieves)

Students in geotechnical engineering laboratory exercises can utilize the USDA web soil survey properly to predict and to interpret the behavior of each kind of soil mapped or to identify under defined situations.

YouTube

YouTube is a video-sharing website which allows billions of people to discover, watch and share videos. YouTube website is now a significant effective tool for classroom instruction. YouTube is not only emerged as a source of entertainment, and more recently, has become a vast resource for quality instructional and educational materials. College students have access to YouTube videos on their daily life basis at anywhere at any time in many ways (Smartphone, Tablet, Laptop and Desktop). Allowing access to YouTube in geotechnical engineering lectures and laboratory creates an opportunity to effectively deliver detail laboratory test sequence with media footages.

Examining common geotechnical engineering laboratory experiments, some of the tests are difficult to proceed at campuses due to time consuming, price costly or strict equipment security. For instance, nuclear density gauge is a radioactive source used for measuring soil density and water content in the field. It is a very convenient equipment associated with sand cone test for soil compaction inspection. Though the radioactivity of the sources is sufficiently low, the gauge is classified as potentially hazardous device and only authorized person can operate the

equipment. The nuclear gauge itself requires two independent security systems to prevent removal of the gauge when in storage. Any misused, damage, lost or other accident must report to the U.S. Nuclear Regulatory Commission. Moreover, several experiments are large scale field tests (Standard penetration test, Cone penetrometer test and etc.) which require commercial facilities to practice at the job site. These factors always restrict the comprehensiveness of geotechnical engineering laboratory categories in most civil engineering programs. YouTube provides a solution which contains primary source footages of soil test process tutorials. These difficult to implement tests can be shown to students via video footages associated with instructor's supplement. As the saying goes, a picture is worth a thousand words. YouTube media provides a revolutionary improvement in classroom which can enrich the geotechnical laboratory experiments. Instructors can also use the video footages to explain the test process and students can also consult the videos via their mobile devices during the laboratory tests.

Some examples of soil laboratory tests presenting in YouTube videos are listed here:

- a. Soil sieve analysis (<https://www.youtube.com/watch?v=-4qqqwzDWvI>)
- b. Soil consolidation test (<https://www.youtube.com/watch?v=3bvevFBNYw0>)
- c. Soil direct shear test (<https://www.youtube.com/watch?v=L1fWPypBP0g>)
- d. Consolidated-undrained shear test (<https://www.youtube.com/watch?v=jnkgS1YtsOA>)
- e. Sand cone and nuclear density tests (<https://www.youtube.com/watch?v=i4hoXJYISkw>)
- f. Atterberg limit tests (<https://www.youtube.com/watch?v=EcXJ961qjGA>)
- g. Cone penetration test (<https://www.youtube.com/watch?v=UWmzRLWecG4>)
- h. Standard proctor compaction test (<https://www.youtube.com/watch?v=25z0MewBj0Q>)

Geotechnical Engineering Project Example

Geotechnical engineering laboratory executed at WVU TECH is an one credit class with three hours laboratory work throughout Spring semester (16 weeks) for undergraduate junior year students. Class size is about 15 students in average. Students have been grouped for 3 or 4 students in one team. In this small group size, students have more hands-on opportunities to perform the soil laboratory experiences. There are five project based assignments containing twelve laboratory experiments. The first laboratory project assignment is titled "Geotechnical Investigations". The assignment requirements and students' partial report presented herein:

Project Purpose

Geotechnical investigations are performed to evaluate those geologic, seismologic, and soils conditions that affect the safety, cost effectiveness, design, and execution of a proposed engineering project. This project requires to determine the geologic setting of the project include: the geologic, seismologic, and soil conditions that influence selection of the project site; the characteristics of the foundation soils and rocks; geotechnical conditions which influence project safety, design, and construction; critical geomorphic processes; and sources of construction materials.[9]

Project Statement

You have been requested by an out of state client to provide reconnaissance information relative to 3 sites in Kanawha County, WV territory that are suitable locations for the construction of a ten acre industrial electronics facility. The information you provide will be used by a combination civil engineering/construction firm located in the client's home town to make an evaluation of the sites in relation to the intended construction.

Each lab group will work as a team to provide a single report. Information that you obtain from soil, geologic, earthquake hazard, flood and other maps and reports will speak to such aspects as the terrain, geologic, soil, flood and earthquake hazard conditions of each of the properties. It will suffice to Xerox and cut and paste such materials where possible to provide tables to which you refer in your final evaluation report.

The selected sites may be in any proper locations with or without exiting building on it.

Project Report Requirements

1. Letter of Transmittal
 - a. Selected locations (each student picks one location)
 - b. Street system for transportation consideration
 - c. Over view of geotechnical engineering aspects
 - d. Suggestion
 - e. Conclusion
2. Soil Survey
 - a. Soil types inside the selected zones
 - b. Content tables with all soil property characterizations
3. Land Suitability and Limitations
 - a. Dwellings
 - b. Corrosion of Steel and Concrete
 - c. Shallow Excavations
 - d. Land Management
4. Soil Properties and Qualities
 - a. Soil Erosion Factors
 - b. Water Feature (Groundwater table depth and Flooding frequency)
 - c. Soil Physical and Chemical Properties
5. Soil Profile (down to 5 ft deep)
 - a. Engineering classifications (USDA, AASHTO and USCS)
 - b. Soil particle sizes distribution
6. Geologic Information
 - a. Geologic properties
 - b. Specific Bed Rock condition
7. Fault line description
 - a. Major fault line (<100 miles)

- b. Surface distance to fault lines
- 8. Earthquake Hazard Evaluation
 - Probabilistic ground motions for
 - Peak Ground Acceleration (PGA) for 5% in 50 Years at 5 Hz,
 - 2% in 50 Years at 10 Hz and 10% in 50 Years at 0.5 Hz
- 9. Existing Building / Property report
- 10. Flood Hazard Evaluation

Student Project Report Example

Project Letter of Transmittal as shown in Figure 1

Tri-Continental Engineering, LLC

February 10, 2015

Confidential Client
 405 Fayette Pike
 Montgomery, WV 25136

Dear Sir or Madam,

You have requested Tri-Continental Engineering, LLC to conduct a geotechnical survey of three potential building sites for an industrial electronics facility. Three potential sites for the facility have been reviewed, and the findings have been compiled in this report for your convenience. The three sites in the Kanawha County area include the Dickinson site near U.S. Highway 60, the Dunbar site near I-64, and the Belle site located near U.S. Highway 60. Detailed location descriptions, a soil analysis for each site, and FEMA flood risk data are enclosed in the report.

Among the three sites chosen, all contain similar properties. All sites are situated near the Kanawha River and have access to major highway and interstate systems. Each potential site is also very flat and would provide a suitable building foundation for such a large manufacturing facility. Also, the construction process would involve very little grading and dirt removal which would help reduce cost. The three sites chosen, however, would need further field tests to verify and collect data that was not found through our research either due to the lack of historical records or the need to provide such detailed information regarding the soil analysis.

We deeply appreciate and enjoyed the opportunity to research these potential job sites for you. We hope this report provides your company with some valuable information about each location. It is a very large step forward for an expanding company, and decisions need to be made only after all information is available. We are here to help and are very understanding. We will answer any questions that arise. We hope to be conducting future tests on these sites for your knowledge and benefit in the future. Once again, we thank you for this opportunity.

Regards,



Michael Powell, PE
 Geotechnical Engineer



James Ramsey, PE
 Geotechnical Engineer



Alejandro Pastor, PE
 Geotechnical Engineer

Report Enclosed

Figure 1. Student project cover letter for “Geotechnical Investigations” assignment

Site selection with satellite image from Google Earth

Site 2: Near South Ridge Beside 119

Latitude: 38.313001 Longitude: -81.732123

Bedrock Type: Conemaugh Group

Bedrock Symbol: Pc

Bedrock Type Description: Cyclic sequences of red and gray shale, siltstone, and sandstone, with thin limestones and coals. Mostly non-marine. May be divided into Casselman and Glenshaw Formations. Extends from the base of the Pittsburgh coal to the top of the Upper Freeport coal. Includes the Elk Lick, Bakerstown and Mahoning coals, and the Ames and Brush Creek Limestones.

Terrain: Flat Open Field

Basement Potential: Very Limited

Road Surface Potential: Very Limited

Depth to Groundwater: Greater than 200 cm



Figure 2. Student project site selected from Google Earth

Site selection associated with topographic map from USGS website

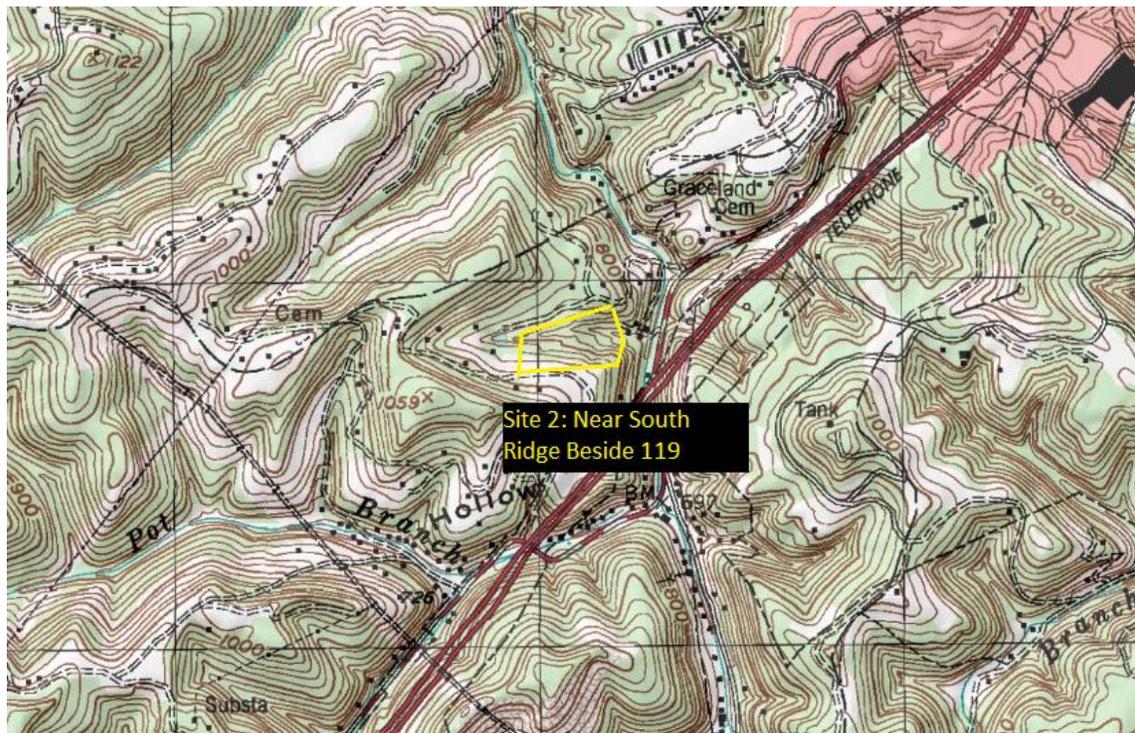


Figure 3. Selected project site on topographic map from USGS website

Soil Survey from USDA web soil survey



Figure 4. Soil types inside selected site from USDA web soil survey

Map Unit Legend			
Kanawha County, West Virginia (WV039)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CDF	Clymer-Dekalb complex, very steep	5.6	56.2%
GpC	Gilpin-Upshur silt loams, 10 to 20 percent slopes	0.0	0.0%
GRF	Gilpin-Upshur silt loams, very steep	0.1	1.5%
GsD3	Gilpin-Upshur complex, 20 to 30 percent slopes, severely eroded	4.2	42.3%
Totals for Area of Interest		10.0	100.0%

Figure 5. Detail soil types with description inside selected site from USDA web soil survey

Kanawha County, West Virginia														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In					Pct	Pct				Pct	
CDF—Clymer-Dekalb complex, very steep														
Clymer	40	B	0-1	Highly decomposed plant material	PT	A-8	—	—	—	—	—	—	—	—
			1-13	Loam	ML, SM	A-4	0	0-5	86-100	63-100	52-95	38-73	27-45	9-18
			13-34	Channery clay loam	GC	A-2	0	0-19	67-96	29-96	24-92	19-73	35-50	18-28
			34-53	Very channery clay loam	GC	A-2	0	11-29	50-80	14-80	13-80	10-65	35-49	18-28
			53-57	Bedrock	—	—	—	—	—	—	—	—	—	—
Dekalb	35	C	0-1	Highly decomposed plant material	PT	A-8	—	—	—	—	—	—	—	—
			1-4	Channery sandy loam	SC, GM, SM	A-2-4, A-1, A-2, A-4	0	0-28	59-92	21-92	15-75	9-47	25-39	6-13
			4-21	Channery loam, very channery sandy loam, channery sandy loam	SC, GC-GM, GM, SM	A-2-4, A-1, A-2, A-4	0	5-36	58-90	21-90	14-71	8-44	18-36	3-12
			21-31	Channery sandy loam, very flaggy loamy sand, very channery sandy loam, flaggy sandy loam	SC-SM, GC, GM, SC, SM	A-1-b, A-1, A-2, A-4	0	11-43	57-92	10-92	7-77	4-43	16-29	2-10
			31-35	Bedrock	—	—	—	—	—	—	—	—	—	—
GpC—Gilpin-Upshur silt loams, 10 to 20 percent slopes														
Gilpin	45	C	0-1	Highly decomposed plant material	PT	A-8	—	—	—	—	—	—	—	—
			1-12	Silt loam	CL	A-4, A-6	0	0-5	81-94	64-94	57-94	48-81	26-45	9-18
			12-31	Channery loam, channery silt loam, channery silty clay loam	CL, GC, SC	A-2, A-6	0	0-28	60-96	18-96	16-96	14-93	27-45	12-25
			31-36	Very channery silt loam, very channery silty clay loam	GC, GC-GM	A-2-6, A-2, A-4, A-6	0	0-32	41-71	13-71	11-71	10-68	25-44	9-25
			36-40	Bedrock	—	—	—	—	—	—	—	—	—	—

Figure 6. Soil engineering properties from USDA web soil survey

Earthquake and Seismic Hazard evaluation from USGS website

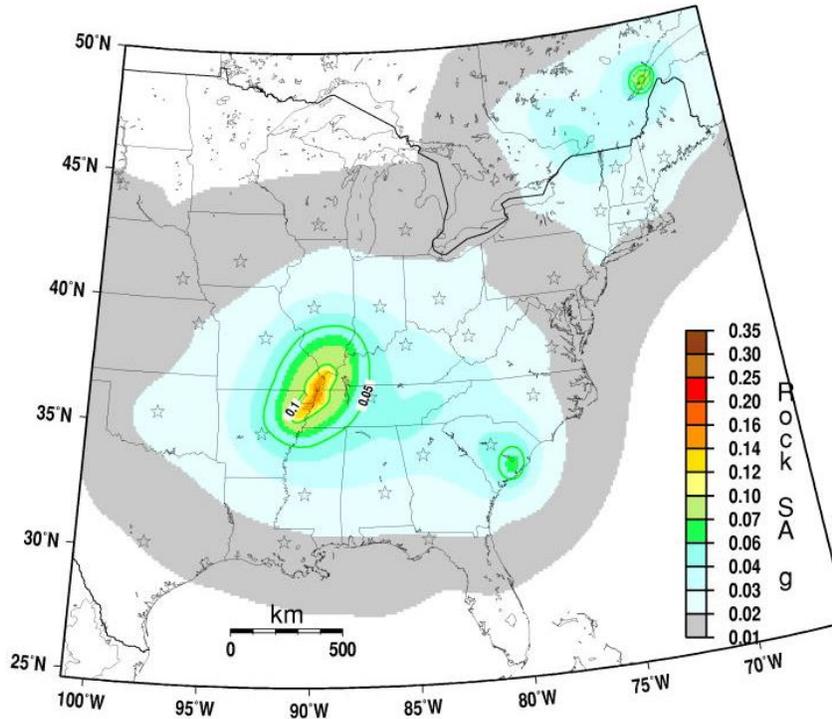


Figure 7. 2008 U.S. Geological Survey National Seismic Hazard Map for 10% in 50 Years Peak Ground Acceleration, Central/Eastern U.S.

Flooding Hazard evaluation from FEMA Flood Map Service

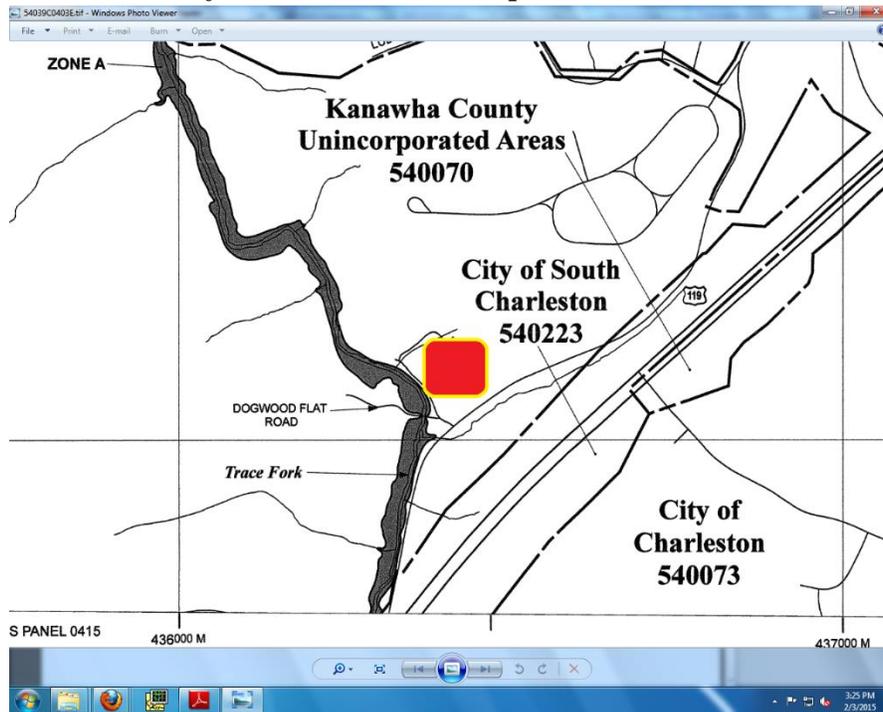


Figure 8. Selected job site projected in FEMA Flood Map

Students Feedback, Instructor Self-Assessment and Learning Outcomes

Students Feedbacks (extracted from student survey)

Student 1: It would have been nice to learn how to use the online resources to do some of these tests before doing all this work and not really understanding the terminology or what the results mean. However this was useful in understanding how everything we do in the lab will be used in geotechnical engineering.

Student 2: After doing this report, I now understand the work a Geotechnical engineer must do in order to complete a soil data report. The amount of data that must be collected is simply astonishing and the preparation for a report this size is astounding.

Student 3: Dr. Yang assigned the practical project to combine the Internet websites into the soil survey report. I really enjoy to learn how to collect data from multiple websites. We also learn how to summarize disordered info from different agencies and to work together as a team.

Instructor Self-Assessment

The author uses a variety of formative assessments in geotechnical engineering laboratory to evaluate student learning. Primary evaluation techniques include student questioning, in-class collaborative learning exercises, experiment questions in three major examinations and short quizzes after student submitting the project reports.^[4] The other main technique is showing suitable YouTube footages and other online resources to assist explanation for laboratory test procedures and theories before some experiments and the others following the traditional teaching method with textbook and laboratory manual. Tracking down three continued years' experience, online resources help students to operate laboratory experiments with less mistakes and to avoid physical accident. The quiz scores also show an apparent improvement compared to previous years' results. Student class survey shows 86% of students rating "Very Satisfied" and "Satisfied" regarding to online resources involved in geotechnical engineering lectures and laboratory experiments. Student course evaluations in the end of semester also indicated positive responds for using online resources in geotechnical laboratory experiments in the past three years.

ABET Learning Outcomes Contribution

Geotechnical engineering laboratory with project based assignments and online resources application can be recognized to contribute to ABET civil engineering program outcomes including ^[2]

- 1 the ability to apply knowledge of math, science, and engineering
- 2b the ability to conduct experiments
- 2c the ability to analyze and interpret data
- 3 the ability to design CE projects
- 4 the ability to function on multi-disciplinary teams

- 5 the ability to identify, formulate and solve civil engineering problems
- 7b the ability to communicate in a written format
- 7c the ability to communicate electronically
- 8 the broad education necessary to understand the impact of engineering solutions in a global and societal context
- 9a a recognition of the need for life-long learning
- 9b the ability to engage in life-long learning
- 10 a knowledge of contemporary issues
- 11 the ability to use modern engineering tools, techniques and skills

Amount the above learning outcomes, online resources application in geotechnical engineering laboratory can be recognized specially supplying learning outcomes 8, 9a, 9b, 10 and 11.

Conclusion

The report titled “College Students in Study Spend 8 to 10 Hours Daily on Cell Phone” put down in writing “A new study from researchers at Baylor University has found that women college students spend an average of 10 hours a day on their cell phones, while men students spend nearly eight hours.” [5] This amazed survey statistics deliver a significant message to college instructors especially in traditional Civil Engineering programs. There is a common classroom policy which prohibits cell phones usage during lectures and laboratory experiments. Most instructors adopt this “No Cell Phone” policy in order to help students focusing in classes or avoiding distraction due to laboratory safety concern. Unfortunately, the realistic situation seems like out of hand in some circumstances. Since the electronic devices and social media are so attractive to college students, the author found out that this is an opportunity to promote teaching strategies through online resources especially in Geotechnical Engineering lectures and laboratory experiments.

Training students to be able to critically analyze open-ended geotechnical engineering design problems is constantly difficult to develop in undergraduate civil engineering programs. The author successfully utilizes the project based model to combine several individual soil tests into practical projects in geotechnical laboratory. Multiple online resources are introduced here for students to apply in geotechnical project based laboratory assignments. These valuable online resources including government agencies (USGS, USDA, FEMA and etc.) and commercial providers (YouTube, Google Earth and etc.) with their applications in laboratory experiments have been mentioned and demonstrated in this article. Refer to students’ learning outcomes and laboratory reports, the achievement of online resources to be used in geotechnical engineering lectures and laboratory experiments is very successful.

The observations on student engagement by the online resources are generally positive in both geotechnical engineering lectures and laboratory experiments. Students were reported to be eager to participate in the laboratory and actively encourage other classmates to search more online resources to strengthen their project reports. Students attentively listened to the instructor’s descriptions with assistance from online video footage and completed the assigned projects on time. As all activities were conducted in small groups with project based model,

informed discussions with online resources assistant often emerged where students failed the tests or debated conflicting results. The positive direction of engaging online resources in geotechnical engineering lectures and laboratory have been verified from student learning outcomes, student feedbacks and test scores. From the above satisfied achievement, it is likely that online resources can be widely adopted in other courses in civil engineering programs.

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Biographical Information

Dr. Horng-Jyh (Tigra) Yang serves as an assistant professor in the Department of Civil Engineering at West Virginia University Institute of Technology. Dr. Yang received his undergraduate civil engineering degree from Chung Yung University and his M.S. from National Pingtung University of Science and Technology in Taiwan. Dr. Yang earned his Ph.D. in geotechnical engineering from the University of Nevada, Reno in 2005. Dr. Yang has more than 10 years teaching experience in geotechnical engineering courses both at the undergraduate and graduate levels.

Dr. Yang’s research interests in geotechnical engineering include soil property characterizations, large scale soil-structure interaction, in-situ soil testing and geotechnical earthquake engineering. Dr. Yang is a registered professional engineer in the state of Nevada and a member of the American Society of Civil Engineering (ASCE), American Society for Engineering Education (ASEE) and the Earthquake Engineering Research Institute (EERI).