

**LIQUEFACTION POTENTIAL & POST EARTHQUAKE
STABILITY ASSESSMENT**

Project ID: CEEEn_2016CPST_013

by

H2J Engineering

Tyler Coutu

Heidi Dacayanan

Josuha Peterson / Equipment Specialist

Joel Yellowhorse / Operations Management

A Capstone project submitted to

Robert Snow

AECOM

**Department of Civil and Environmental Engineering
Brigham Young University**

November 7, 2016

Introduction

PROJECT TITLE: Post-Liquefaction & Earthquake Stability Assessment
PROJECT ID: CEEEn-2016CPST-013
PROJECT SPONSOR: AECOM
TEAM NAME: H2J Engineering

In order to accommodate the new Bus Rapid Transit (BRT) route in Provo and Orem, UT, many roads and bridges must be adjusted. One of these bridges located on University Pkwy. between Freedom Blvd. And 550 West in Provo is being widened to add more lanes. AECOM's geotechnical group in Salt Lake have requested that we submit a proposal for a geotechnical assessment of the bridge involved. The purpose of this assessment is to identify the effects of a future earthquake on the bridge and any associated structure. This project proposal contains our plan, schedule, budget, and all other necessary details for us to complete this task. The major phases of this project will include the following

- Analysis—We will be using the SPT boring data provided in order to create models of the desired location
- Research—During this phase we will explore all possible implications of the situation and make sure our conclusions align with the most up-to-date methods of geotechnical research
- Evaluation—Finally, we will create a report detailing liquefaction as well as other hazards and their associated risks caused by a future seismic event.

These phases will be completed over the next several months. A more detailed schedule is given later in this report. The final objective of this project is to create a document that gives sufficient information on potential hazards from a future earthquake so that proper remediation can take place. We are confident that our team can complete all these objectives and we are looking forward to our cooperation on this project.

H2J Engineering

Robert Snow
Project Representative
AECOM

November 18th, 2016

H2J engineering has created this proposal in response to a request sent out for the liquefaction & post-earthquake stability assessment of the bridge located on University Pkwy. between Freedom Blvd. And 550 West in Provo, Utah. We are excited for the opportunity to apply for this project and we are confident that our team has the necessary skills to complete this project in a timely and efficient manner. The contents of this proposal are given as:

- Introduction
- Proposed work plan
- Schedule
- Facilities, tools, data, and equipment
- Project budget
- Deliverables
- Statement of qualifications
- Appendix

Again, we are excited to work with you and our team will put forth its best efforts to meet all expectations.

Please contact us if you have any questions. You can email us at joelyellowhorse@gmail.com or by phone at 801-615-9753.

Proposed Work Plan

Our approach to this work will be systematic and will include our best efforts to provide a detailed report of the data recovered from the bridge site. The majority of the project will be research based and will require outside expertise from experts in related subject matter. Several phases of analysis will be necessary in order to ensure an accurate assessment of the bridge site. A detailed outline is shown below.

1. Data retrieved will be analyzed thoroughly. Both SPT boring logs and the drill hole log data will be organized and plotted into AutoCAD. Necessary interpolations will be made where data is absent and a general summary of the materials present under the bridge site will be compiled.
2. Historical data from similar bridges built over comparable soil will be compiled. This information will be useful in providing context for the project as well as being useful in predicting costs for damage or retrofitting that may need to be done.
3. A detailed list of soil characteristics that relate to earthquake hazards and liquefaction potential will be compiled. This will include fines content, estimated shear strength, moisture content, and effective stress for the soil.
4. The likelihood and nature of a future seismic event will be researched at this point. Any necessary data about the magnitude and intensity of previous earthquakes will be taken and used as a model for upcoming occurrences. The location and activity of surrounding fault lines will be recorded and added into the final report.
5. Each of the determining soil characteristics will be examined individually under different forces caused by a range of several possible earthquake scenarios. Different possible outcomes for each of these soils will be considered. The structural plans for the bridge will be referenced and any necessary information will be noted. Finally, a summary of the most likely events will be drawn up.
6. Risk assessment will be performed in order to give an estimate of the likelihood that an earthquake strong enough to cause damage will occur and whether that damage is likely to be significant. This assessment will consider 10, 20, and 40 year risk evaluations and the associated outcomes for possible events.
7. A report will be written up containing all relevant research information. This report will give a summarized risk assessment as well as any recommendations or conclusions derived from the analysis.

As each of these steps are completed regular emails will be sent to the sponsoring organization's representative with a summary of the work performed and any important conclusions. The length of each of these phases may vary depending on available resources. However, to ensure the timeliness of the project a list of deadlines for each section is attached and will be only adjusted in coordination with the organization representative. Participation from all team members as well as consulting subject matter experts will ensure the accuracy of the work. Resumes are attached showing the qualifications of each team member and what they will contribute to this project.

Schedule

Individual Weekly Work Schedules

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Joshua Peterson		3:00PM to 5:00PM	3:00PM to 5:00PM		3:00PM to 7:00PM		
Heidi Dacayanan		1:00PM to 6:00PM	8:00AM to 9:00PM	1:00PM to 3:00M	3:00PM to 7:00PM		
Joel Yellowhorse				9:00AM to 11:00AM	2:00PM to 5:00PM	11:00AM to 12:00PM	

Project/Final Report Timeline

- Monday, January 9, 2017 – 3:00 PM Team meeting
- January 9th through January 23rd – Use boring logs, drilling notes and observations to create a detailed cross section of the soil stratigraphy.
- Monday, January 23, 2017 – 3:00 PM Team meeting
- January 23rd through January 30th – Compile historical data from similar bridge/soil situations and use to evaluate costs for damage/retrofitting that may need to be accounted for.
- Monday, January 30, 2017 – Monthly status report #1
- Monday, January 30, 2017 – 3:00 PM Team meeting
- January 30th through February 13th – Compile a list of soil characteristics that relate to earthquake hazards and liquefaction potential and relate to our site soil conditions.
- Monday, February 13, 2017 – 3:00 PM Team meeting
- February 13th through February 27th – Analyze likelihood and nature of a future seismic event at the bridge location.
- Monday, February 27, 2017 – Monthly status report #2
- Monday, February 27, 2017 – 3:00 PM Team meeting
- February 27th through March 13th – Evaluate soil characteristics under several possible seismic scenarios.
- Monday, March 13, 2017 – 3:00 PM Team meeting
- March 13th through March 27th – Perform a risk assessment to estimate likelihood and extent of damage due to a seismic event and complete a rough draft of final project report.
- Monday, March 27, 2017 – Monthly status report #3
- Monday, March 27, 2017 – 3:00 PM Team meeting
- March 27th through April 3rd – Edit/complete final report, create poster, and prepare presentation.
- Monday, April 3, 2017 – 3:00 PM Team meeting
- April 3rd through April 10th – Practice presentation as a group and finalize report/poster.
- Monday, April 10, 2017 – Completed project report, poster, and presentation will be submitted

Facilities, Tools, Data and Equipment

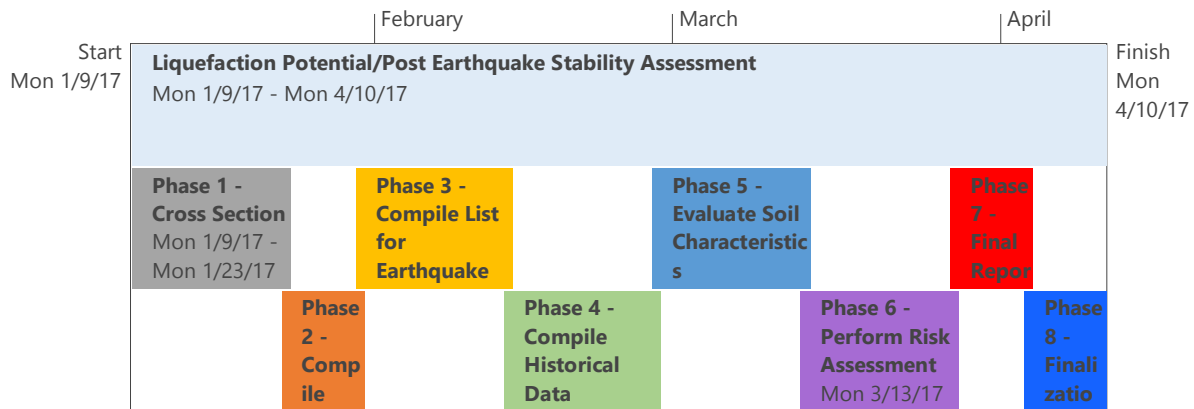
The soils lab facilities and tools at BYU will be used for any soil tests that may be required to complete this project. The BYU facilities will also be used for meetings and research as required. AutoCAD, Excel, PowerPoint and Word will be required to complete the project report, presentation and poster. All relevant data has been provided by AECOM and includes the following:

1. AECOM Provo River Bridge Plans
2. Boring Locations and Logs
3. RB&G Logs

No other facilities, tools, data, or equipment is expected to be required.

Project Budget

It is estimated to be a max of 1,584 hours total put into the project, roughly 528 hours for each team member over a 4 month period between January 9, 2017 and April 10, 2017. A calendar timeline based on the time line given above was made and separated into eight phases and is given below. Phases 1-4 are primarily research, 5-6 is analysis, and 7-8 is evaluation.



Task Name	Duration	Start	Finish
Liquefaction Potential/Post Earthquake Stability Assessment	66 days	Mon 1/9/17	Mon 4/10/17
Phase 1 - Cross Section	11 days	Mon 1/9/17	Mon 1/23/17
Team Meeting	1 day	Mon 1/9/17	Mon 1/9/17
Create Cross Section of the Soil Stratigraphy	10 days	Mon 1/9/17	Fri 1/20/17
Review and modify the strategic plan	2 days	Fri 1/20/17	Mon 1/23/17
Team Meeting Confirm Decision to Proceed/ Plan Next Step	1 day	Mon 1/23/17	Mon 1/23/17
Phase 2 - Compile Historical Data	6 days	Mon 1/23/17	Mon 1/30/17
Historical Data from Similar Bridge/Soil Situations	3 days	Mon 1/23/17	Wed 1/25/17
Evaluate Cost	3 days	Wed 1/25/17	Fri 1/27/17
Review and modify the strategic plan	2 days	Fri 1/27/17	Mon 1/30/17
Team Meeting Confirm Decision to Proceed/ Plan Next Step	1 day	Mon 1/30/17	Mon 1/30/17
Monthly Status Report 1	1 day	Mon 1/30/17	Mon 1/30/17
Phase 3 - Compile List for Earthquake Hazards and Liquefaction	11 days	Mon 1/30/17	Mon 2/13/17
Compile List of Soil Characteristics	11 days	Mon 1/30/17	Mon 2/13/17
Research Earthquake Hazards in site	7 days	Mon 1/30/17	Tue 2/7/17
Liquefaction Potential Related to Site	7 days	Thu 2/2/17	Fri 2/10/17

Review List	2 days	Fri 2/10/17	Mon 2/13/17
Team Meeting: Confirm decision to proceed	1 day	Mon 2/13/17	Mon 2/13/17
Phase 4 - Compile Historical Data	11 days	Mon 2/13/17	Mon 2/27/17
Research Previous Seismic Events in Area	11 days	Mon 2/13/17	Mon 2/27/17
Research Events Data	2 days	Mon 2/13/17	Tue 2/14/17
Organize Event Data	2 days	Tue 2/14/17	Wed 2/15/17
Find Similarities	2 days	Tue 2/14/17	Wed 2/15/17
Write Up a Document with Data	5 days	Thu 2/16/17	Wed 2/22/17
Start Analysis	3 days	Thu 2/23/17	Mon 2/27/17
Predict likelihood of Future Events and Analyze Effects	2 days	Thu 2/23/17	Fri 2/24/17
Team Meeting and Review Analysis And Monthly Report 2	1 day	Mon 2/27/17	Mon 2/27/17
Phase 5 - Evaluate Soil Characteristics	11 days	Mon 2/27/17	Mon 3/13/17
Research Previous Seismic Events in Area	11 days	Mon 2/27/17	Mon 3/13/17
Testing different seismic scenarios	9 days	Mon 2/27/17	Thu 3/9/17
Write Analysis	2 days	Wed 3/8/17	Thu 3/9/17
Review Analysis Write-up	2 days	Fri 3/10/17	Mon 3/13/17
Team Meeting	1 day	Mon 3/13/17	Mon 3/13/17
Phase 6 - Perform Risk Assessment	11 days	Mon 3/13/17	Mon 3/27/17
Research the Risk	11 days	Mon 3/13/17	Mon 3/27/17
Calculate the risk and extent	4 days	Mon 3/13/17	Thu 3/16/17
Complete Rough Draft of Final Project Paper	9 days	Tue 3/14/17	Fri 3/24/17
Monthly Report	1 day	Mon 3/27/17	Mon 3/27/17
Team Meeting	1 day	Mon 3/27/17	Mon 3/27/17
Phase 7 - Final Report	6 days	Mon 3/27/17	Mon 4/3/17
Edits and Preparing	6 days	Mon 3/27/17	Mon 4/3/17
Edit/Complete Final Report	4 days	Mon 3/27/17	Thu 3/30/17
Start Poster	2 days	Thu 3/30/17	Fri 3/31/17
Prepare Presentation	2 days	Thu 3/30/17	Fri 3/31/17
Team Meeting/ Monthly Report 3	1 day	Mon 4/3/17	Mon 4/3/17
Phase 8 - Finalizations	6 days	Mon 4/3/17	Mon 4/10/17
Practice and Finishing	6 days	Mon 4/3/17	Mon 4/10/17
Practice Presentation	3 days	Mon 4/3/17	Wed 4/5/17
Finish Report/Poster	4 days	Wed 4/5/17	Mon 4/10/17
Submit report, poster, and presentation	1 day	Mon 4/10/17	Mon 4/10/17

Deliverables

All deliverables are due on Monday, April 10. There will be a presentation given to both the sponsors and university before the end of winter semester. The final report on liquefaction potential sites will be written in word and will be summing up the explanation of our findings, judgement calls, and recommendations. Multiple soil cross section AutoCad models will be produced to show soil stratigraphy based on SPT and CPT logs and engineering judgement.

There will be short monthly reports answering 4 different questions: what types of challenges were encounter, how challenges were handled, what progress was made on listed challenges, and is the project is still on schedule?

A final report with the analysis results, economic and environment considerations, monthly report will be typed up. A poster reflecting the summary of the project presented to faculty and students given by H2J Engineering, and a presentation summarizing the projected presented to the sponsor will also be prepared.

Performance Standards

Team will provide work for this Capstone project “as is” using best practices and with best effort. Project results cannot be construed as work performed by licensed professionals and cannot be used as “stamped deliverables” without first being reviewed, approved and stamped by a qualified and relevant license professional engineer.

Statement of Qualification

We have specifically selected the members of our team to best facilitate teamwork and quality effort on this project. All of our team members have relevant skills that are key to the success of this project. Their names and a summary of what they contribute are listed below.

- Heidi Decayanan—As the team leader has had years of experience doing research in water resources and now has recently declared a geotechnical emphasis to her degree. Her firsthand experience with doing laboratory work will be essential to the completion of the project.
- Joshua Peterson—As the equipment specialist, Joshua Peterson will be our primary resource when working with the required engineering programs. He has had years of work experience designing in AutoCAD and has a great attention to detail when creating presentations of the material.
- Joel Yellowhorse—As the project manager has the responsibility to do secretarial work. He has had experience managing conferences and organizing presentations for groups of up to 100 people.
- Tyler Coutu—As the project mentor Tyler Coutu will be essential in the overall guidance of our team. He is currently studying liquefaction and is completing his master's degree in geotechnical engineering.

Our team is well prepared to take on the challenge of this project and will perform to the expected standards. Again we are excited for the opportunity to apply for this project.

Appendix A

Heidi Dacayanan

heidi.dacayanan@yahoo.com

Las Vegas, NV 89183

702-292-7600

Objective: Find a place where I can contribute my skills, expand my knowledge, and further my career.

Educational Experience

Bachelor of Science, Brigham Young University, expected April 2017

Major: Civil Engineering

Emphasis: Water Resources and Environmental, and Geotechnical

GPA: 3.04/4.0

Professional Experience

Research Assistant, August 2014-April 2016

Professor Hotchkiss, Provo, Utah

- Collecting velocity data for culvert research
- Teaching 40 students about hydraulic jump safety for civil engineering presentation
- Aiding in making model for hydraulic jump solution proposal
- Compiling accident data for dam accident excel sheet

Intern Lab Attendant, August 2013-June 2014

Professor Hotchkiss, Provo, Utah

- Gathered data for hydraulic jump research
- Assisted graduate student for flume chamber research
- Observed research of four graduate students for experience
- Collaborated information for research meeting

Professional Memberships

- National American Society of Civil Engineers
- BYU American Society of Civil Engineers student chapter

Residences

- **Provo, Utah** August 2013- Present
- **Lajes, Azores, Portugal** June 2011- June 2013
- **Misawa, Japan** April 2006- June 2011
- **Las Vegas, Nevada** June 2002-April 2006
- **Yokota, Japan** June 1998-June 2002

Skills

Computer Experience: ArcGIS, Excel Visual Basic for Application, Auto CAD, Revit

Machinery: Flume Chamber, CBR machine, Marshall Machine, Sieve Machine, Hydrometer

References Available Upon Request

Joshua G. Peterson

1545 South 320 East, Orem, Utah 84058 | (385)312-6502 | joshuapeterson65@gmail.com

Education

B.S. CIVIL & ENVIRONMENTAL ENGINEERING | BRIGHAM YOUNG UNIVERSITY; PROVO, UTAH | EXPECTED: DEC. 2017

- Passed the FE exam.
- Emphasized in Structural Design with wood, steel, and concrete materials.
- Minored in Mathematics.
- 3.72/4.0 GPA.
- Related coursework: CAD software classes including Autodesk AutoCAD, Revit, and Solid Works.
- *Award of Excellence* (2013) for academic success in undergraduate coursework.
- *Richard V. Harris Endowed Scholarship* (2015, 2016) for academic performance and dedicated service.

Experience

STRUCTURAL ENGINEER | LEI ENGINEERS & SURVEYORS | BLUFFDALE, UTAH | SEP. 2014-PRESENT

- Engineered buildings for seismic and gravity framing systems with steel, concrete, wood, and masonry design.
- Used programs such as Revit, Autodesk AutoCAD, Strucalc, Enercalc, Retain Pro, Forte, BC Calc, and Excel in engineering process.
- Trained new employees for 1 to 3 months.
- Communicated frequently with clients through letters, email, and verbal communication during design and construction process.

FINISH CARPENTER/FRAMER | HOPE CUSTOM BUILDING | SALT LAKE CITY, UTAH | SEP. 2012- OCT. 2014

- Gained firsthand experience in the constructions industry.
- Read and interpreted plans for a variety of projects.
- Framed and performed finish carpentry work.
- Collaborated with clients to insure specific design and layout of individual projects.

ONLINE ESL INSTRUCTOR | OPEN ENGLISH | REXBURG, IDAHO | APR. 2013- OCT. 2014

- Led English classes ranging in size from 1 to 10 students of all skill levels.
- Communicated through audio and writing in English, Spanish, and Portuguese.
- Managed class lessons as well as working hours.

Service

MISSIONARY | THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS | SAO PAULO, BRAZIL

- Led 10-20 missionaries for 3 months with weekly training meetings, progress reports and daily follow-up calls.
- Taught English as a second language to native Brazilians.

Joel Yellowhorse

168 S. 900 W. Provo, UT, 84601 Cell: 801-615-9753 Email: joelyellowhorse@gmail.com

Education

- GPA: 3.90
- AS in Pre-Civil Engineering from UVU
- 3 time Dean's List Member
- Outstanding Student of the Year at UVU in science and technology
- 4 different scholarship awards for academic achievement

Work Experience

Private Tutor.....August 2011 to May 2013
Utah Valley University

- Taught advanced mathematics, physics, chemistry, engineering
- Scheduled group meetings and conducted learning discussions
- Received multiple recommendations and referrals for my tutoring service

The Church of Jesus Christ of Latter Day Saints.....October 15th, 2015 to August, 2016
Provo, Utah

- Led groups of 4 to 12 volunteers to perform custodial work at the Provo Temple
- Responded to needs from patrons when problems arose in the services
- Assisted in the indoor and outdoor maintenance of cleaning equipment and facilities

Engineering materials Teaching Assistant.....August, 2016 to Present
Brigham Young University

- Worked as a teachers aid grading assignments and helping students have a learning experience
- Demonstrated proper methods for testing material and soil specimens in a lab
- Worked as a team with other aids to meet the course schedule

Skills

- Proficiency with Microsoft Word, Excel, Power Point, Access, AutoCAD, and Revit 2016
- Familiarity with programming languages such as VBA, HTML, and C#
- Excellent reading comprehension and writing abilities
- Proficiency with concepts relating to mathematics, physics, and chemistry
- Knowledge of CNC laboratory equipment and corresponding data collection
- Fluency in Spanish reading and writing