SPRINGVILLE PERFORMANCE EVALUATION & PAVEMENT DESIGN FOR MINOR COLLECTORS

Project ID: CEEn_2018CPST_013

As performed by

Team MagiCAP

Craig Staples

Alec Escamilla

Paul Andersen

A Capstone Project 30% Completion Report

Submitted to

Dr. W. Spencer Guthrie, PhD

Representing the City of Springville

Department of Civil and Environmental Engineering

Brigham Young University

10 December, 2018

Executive Summary

PROJECT TITLE:	Springville Performance Evaluation & Pavement Design for Minor Collectors
PROJECT ID:	CEEn_2018CPST_013
PROJECT SPONSOR:	City of Springville
TEAM NAME:	MagiCAP

A recently completed study of pavement performance in Springville City indicated that minor collectors were failing prematurely. Evaluations of selected minor collectors are needed to determine the cause(s) of premature failure, and a new pavement design is likely warranted. Completion of the project will require field work and will allow team members to learn more about pavement design.

The desired outcomes of the project include an explanation(s) for the premature failure observed on selected minor collectors and, if warranted, a new pavement design for minor collectors in the city.

The timeline to complete this project is explained in further detail in the "Schedule" section of this document. The field work aspect of the project is anticipated to be completed before the end of the 2018 calendar year. The target completion date for the required laboratory work will be before the end of February, 2019. A physical report will be completed by the end of March, 2019. A poster summarizing the project, findings, and recommendations will also be completed by the end of March, 2019.

There are two key deliverables for this project. The first will be a report explaining the premature failure observed and may include a new pavement design. The second is the poster described in the previous paragraph.

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Introduction

A recently completed study of pavement performance in Springville City indicates that minor collectors are failing prematurely. Evaluations of selected minor collectors are needed to determine the cause(s) of premature failure, and a new pavement design is likely warranted. The project was broken down into checkpoints by the Capstone team. These checkpoints are outlined in the project schedule and consist of data collection and field work, laboratory experimentation, and post-processing of the collected data.

Preliminary assumptions and expectations are that the premature failures are being caused by construction specifications for minor collectors that deviate from the ASTM standards, or that the standard for minor collectors is insufficient for the loads and weathering to which these specific streets are subjected. It is initially assumed, until proven otherwise, that all minor collectors were constructed according to the engineered specifications.

It is expected that during laboratory testing the cause(s) of the collector failure will be identifiable and treatable. The capstone team anticipates a total of 180 work hours per team member to complete this project. This includes all overhead work, field and laboratory work, and data post-processing.

The final report will consist of a report summarizing the laboratory and field work, together with a poster summarizing the results of this study, complete with the team's recommendations for pavement design improvements or remedial action (as necessary).

Schedule

Task Name	Start Date	End Date	Assigned To	Duration	% Complete	Notes
Section 1 - Preliminary Groundwork	**08/28/18**	**12/10/18**		**75d**	**94%**	
Regular Status Report 1	08/28/18	10/01/18	Paul	25d	100%	
Define Lead Measures for WIG	09/01/18	10/01/18	All	22d	100%	
Draft SOW for Dr. Guthrie	09/01/18	10/08/18	All	27d	100%	
Schedule Field Testing w/ Dr. Guthrie	10/01/18	12/10/18	All	51d	75%	
Regular Status Report 2	10/08/18	10/15/18	Craig	6d	100%	
Regular Status Report 3	10/15/18	10/22/18	Alec	6d	100%	
Regular Status Report 4	10/22/18	10/22/18	Paul	1d	100%	
Regular Status Report 5	10/29/18	11/05/18	Craig	6d	100%	
Regular Status Report 6	11/05/18	11/12/18	Alec	6d	100%	
Regular Status Report 7	11/12/18	11/19/18	Paul & Alec	6d	100%	
Regular Status Report 8	11/19/18	11/26/18	Craig	6d	100%	
30% Completion Report	10/01/18	12/10/18	All	51d	100%	
Section 2 - Field Testing & Lab Work	**11/01/19**	**03/16/20**		**97d**	**8%**	
Collect Samples	11/01/19	01/31/20	All	66d	15%	
Prepare Laboratory Testing Plan	11/01/19	01/01/20	All	44d	10%	
Perform Laboratory Tests	01/13/20	03/16/20	All	46d	0%	
Compare Laboratory Tests with standard practices	02/03/20	03/16/20	All	31d	0%	
Section 3 - Deliverables	**02/03/20**	**04/06/20**		**46d**	**0%**	
Summarize Laboratory Testing in Report Format	03/17/20	03/30/20	All	10d	0%	
Construct Visual Poster	03/31/20	04/06/20	All	5d	0%	
Write Report	02/03/20	04/06/20	All	46d	0%	

FIGURE 1: CAPSTONE GANTT CHART - GRID VIEW

Assumptions & Limitations

At this time our progress has been slowed due to coordination delays with the City of Springville and our team. Some tests have been performed in the field, but we are now waiting for analyses to be run on the field tests. Our capstone team will maintain contact with Dr. Guthrie and his graduate research assistants so that the project can progress as soon as possible.

From the preliminary tests and visuals that Dr. Guthrie and his graduate research assistants conducted, it is assumed that the base materials used in the construction of the minor collectors were weaker than the underlying subgrade. Until further analysis can be conducted, we will continue with the assumption that the base materials will need to be removed or strengthened for the final design of the minor collectors.

Design, Analysis & Results

Preliminary testing on the asphalt of five separate roads in Springville have been conducted. An analysis of the data from these tests has been performed by Dr. Guthrie's graduate students and it has been determined that the base material is weaker than the subgrade material. A more thorough analysis both in the field and in the laboratory will be conducted to further determine what measures should be implemented by the City of Springville.

The laboratory tests that will be run on the samples we will collect include proctors, California Bearing Ratio tests (CBR), LA Abrasion tests, sieve analysis, and Unconfined Compressive Strength tests (UCS). The results of these tests will be collected and analyzed according to our schedule above.

Lessons Learned

To this point in the project our team has learned more about project development and management than we knew at the beginning of the semester. We learned the importance of recording and tracking hours specifically for all tasks involved with the project. Categorizing the efforts towards the project is a necessary and important element in billing accurately. We have learned that having a dashboard to report our completion status and billable hours is the most honest and transparent way to do business. This kind of transparency builds trust with the client. Even when progress might be slower than anticipated it is especially important to communicate and be transparent.

Our team has begun to learn more technical details about the project as well. Being bottlenecked in our physical progress (i.e. laboratory testing, etc.) has not meant that we are completely stopped. During these slow periods we have been able to educate ourselves on the potential issues, and prepare a game-plan for the testing we will perform once the samples are ready for testing. The mind map and flow chart exercises that we performed as a team helped us to approach the problem from a number of angles so that we could be most effective with the laboratory resources available to us. In short, we learned that preparation will lead to more efficient uses of our time for the remainder of the project.

Conclusions

So far, our team cannot conclude anything with certainty. However, based on the knowledge of Dr. Guthrie, we are currently assuming that the base materials used in construction were weaker than the underlying subgrade layer. Until further analysis can be performed, additional conclusions cannot be offered.

Recommendations

Our current recommendation can only be to perform additional analyses. Without data no significant or accurate recommendations can be made. Our final recommendations will be presented in April, 2019 and will be based off of comprehensive examination and analysis of the specimens and site conditions.

Appendix A

Aleczander N. Escamilla

100 S Geneva Rd. #L205, Vineyard, UT 84058 | alec.escamilla@gmail.com | (818) 319-1270

EDUCATION

Brigham Young University — **Provo, UT**
B.S. Civil Engineering; Minor: Business Management — Apr 2020
- GPA: 3.94/4.00; ACT: 29/36 (92nd percentile)
- Harvard Business School Peek Weekend Ambassador
- Marigold N. Saunders merit-based scholarship and W. Don Budge Civil Engineering merit-based scholarship recipient

EXPERIENCE

PricewaterhouseCoopers — **Dallas, TX**
Start Advisory Intern — Jun 2018 – Jul 2018
- Created a best-in-class client deliverable that visually connects PwC's service offerings to their 6 FY19 platforms
- Enhanced the ability of sales teams to bring the One Firm methodology to the client
- Developed strong relationships while balancing multiple projects and allowed for greater focus on high impact work

Brigham Young University — **Provo, UT**
Research Assistant in Department of Civil and Environmental Engineering — Oct 2016 – Present
- Perform 20+ unconstrained shear testing using a Universal Testing Machine to determine effectiveness of geogrid
- Work directly with a Master's student to publish a thesis through BYU and in an academic journal
- Work independently and collaboratively on preparing, compacting, and testing 20+ different soil samples

W.W. Clyde & Co. — **Orem, UT**
Engineer Intern — May 2017 – Dec 2017
- Drove over $60,000 in savings on a $19 M project by finding value engineering opportunities
- Created a production schedule using Excel in order to keep the project profitable and to meet established goals
- Verified accuracy of reported quantities for payment and created 15+ submittals for various project phases
- Managed the purchasing and supervised the installation of 3,000+ yards of storm drain
- Identified design deficiencies and worked with owners, designers, and subcontractors to correct them

Intertek PSI — **Oklahoma City, OK**
Engineer Intern — May 2016 – Aug 2016
- Supervised the pouring and performed quality control testing of concrete on 20+ projects, often between 1 am-6 am
- Ran a variety of lab tests including Atterberg Limits, California Bearing Ratios, Proctors, and Resistivities
- Demonstrated ability to learn and fill multiple roles including as a driller's assistant, boring twenty 15-45 foot deep holes
- Certified American Concrete Institute 1 technician with only a few days of training

Brigham Young University — **Provo, UT**
Residence Assistant — Jan 2016 – Apr 2016
- Helped create and supervise a healthy community directly with 38 residents and upwards of 150 indirectly
- Planned, organized, and ran 4 events to encourage development of healthy life habits available to hundreds of students
- Met weekly with about 20 residents to lead discussions on community standards and life skills

SERVICE AND LEADERSHIP

Cougar Consulting Group — **Provo, UT**
Engagement Manager and Founding Team Member — Mar 2018 – Present
- Developed a quantifiable, data-driven strategy to determine an international office location for a fast-growing SAAS client

Engineers Mean Business Club — **Provo, UT**
Treasurer and former Vice President of Events — Jan 2017 – Present
- Planned, organized, and coordinated events that would increase members professional networks and their business skills
- Worked directly with professionals in engineering, entrepreneurship, tech, and others to inspire club members

American Society of Civil Engineers BYU Student Chapter — **Provo, UT**
President, Concrete Canoe Team Member, and Heavy Civil Construction Management Case Competitor — Aug 2017 – Present
- Coordinate the efforts of 14 other officers to provide service, leadership, and networking opportunities to over 200 students
- Authored and presented a non-technical paper that won 1st place overall at the ASCE Rocky Mountain Conference
- Helped build a canoe made out of concrete that not only floats but is used for several different races against other schools
- Led a team of 6 to analyze, schedule, bid, and present a construction management case competition in 24 hours

The Church of Jesus Christ of Latter-day Saints — **Oaxaca, Mexico**
Bilingual Service Representative — Aug 2013 – Jul 2015
- Coordinated the daily efforts of over 30 other representatives to improve the lives of the people in Oaxaca
- Organized and presented weekly and bi-monthly leadership training conferences that focused on interpersonal skills
- Adapted to an international environment by working with local leaders and immersing myself in the culture

PERSONAL

- Starting to learn Finnish
- Inner tube water polo goalie

CRAIG STAPLES

469 Wymount Terrace, Provo, UT 84604 ♦ 530-635-4475 ♦ castaples14@gmail.com

Objective: Seeking opportunities in field engineering, specializing in material testing.

EDUCATION

APRIL 2019 EXPECTED — **Brigham Young University** — **Provo, UT**

BS CIVIL ENGINEERING 3.83 GPA Civil Engineering Scholarship ASCE National Member

KEY UNIVERSITY COURSE WORK:

Elementary Soil Mechanics, Statics and Dynamics, Geomatics and GIS, Hydraulics, Structural Analysis, Differential Equations, Calculus

EXPERIENCE

AUGUST 2017-PRESENT — **Brigham Young University Civil Engineering Department** — **Provo, UT**

SOIL MECHANICS LABORATORY INSTRUCTOR

- Guided 7 students on a weekly basis through real-world laboratory exercises
- Critiqued weekly technical writing on laboratory group reports and gave quality feedback
- Assisted students during weekly office hours with university soil mechanics coursework

SUMMER 2017 — **RB&G Engineering** — **Provo, UT**

LABORATORY TECHNICIAN

- Sampled, tested and provided quality assurance work on 300+ soil samples
- Completed rice, gyratory, Marshall, and burnoff tests on 300+ asphalt samples
- Performed slump, air and compressive tests for airport hangars at the Salt Lake City International Airport

SUMMER 2015 — **Clark Pacific Engineering Firm** — **Woodland, CA**

HEALTH AND SAFETY INTERN

- Worked closely with 4+ civil engineers, monitoring high danger area safety concerns
- Implemented and conducted daily safety inspections, identifying and mitigating safety concerns for 100+ employees to ensure safe working conditions
- Evaluated reported injury data using Microsoft Excel and Word to reduce employee injury

VOLUNTEER/SERVICE

APRIL 2017-PRESENT — **BYU American Society of Civil Engineers (ASCE)** — **Provo, UT**

CLUB SECRETARY

- Documented weekly officer meting minutes with assignment follow up
- Conducted weekly club meetings for 250+ students

2011-2013 — **The Church of Jesus Christ of Latter-day Saints** — **Paris, France**

VOLUNTEER REPRESENTATIVE

- Trained 6 missionaries in essential French speaking, teaching, and planning skills
- Prepared weekly trainings for 8 missionaries during a two-month period

SKILLS AND ACHIEVEMENTS

- Computer skills:
  - Excel (including VBA)
  - AutoCAD, Revit
  - ArcMap/GIS
  - Google Docs and Sheets
  - Microsoft Word, PowerPoint, Photo shop
- OSHA 10 Hour Trained
- Eagle Scout, Boy Scouts of America

Paul JW Andersen

linkedin.com/in/paul-jw-andersen
385-207-9395 * paolo.andersen@gmail.com

Education

Brigham Young University Apr 2019
BS Civil & Environmental Engineering Provo, UT

- 3.79 cumulative GPA, member of Tau Beta Pi Engineering Honor Society
- Minor: Business
- Relevant Coursework: Design of Wood Structures, Structural Steel Design, Reinforced Concrete Design, Geotechnical Engineering, Geology for Engineers, Fluid Mechanics, etc.

Work Experience

Acute Engineering Nov 2017 - Present
Structural Engineering Intern Orem, UT

- Provided light-frame engineering in accordance with ASCE 7-10, NDS, SDPWS, IBC, IRC and local code
- Institutionalized universal shallow foundation details for projects outside of Utah County

Brigham Young University May 2018 - Present
Field Research Assistant to Dr. Kyle Rollins Provo, UT

- Collaborated with professors from BYU and Università di Bologna, in a ground improvement study using rammed aggregate piers to mitigate liquefaction potential in susceptible soils (sponsored by Geopier Foundation)
- Assisted with field testing at site in Bondeno, Italy and post-experiment data analytics using Excel and VBA

South Valley Sewer District Jun 2017 - Aug 2017
Wastewater Engineer Intern Bluffdale, UT

- Reviewed and revised all sewage plans with district and staff engineers for all new construction projects within the largest utility district in Utah
- Programmed with VBA to reduce regular data entry time from 15 hours to 1 hour

Qualtrics, LLC. Dec 2016 - Nov 2017
Project Manager Provo, UT

- Managed research studies across numerous industries, utilizing Qualtrics software and strategic sampling

Product Specialist Sep 2013 - Dec 2016

- Provided customer service to companies such as Bain & Co., Google, PWC, Allianz, etc.
- Promoted internally resulting in a doubling of personal hourly pay (starting $8/hr., end $17.50/hr.)

Carescape Sprinkler and Landscape Gurus Jun 2013 - Sep 2013
Operations Manager Heber City, UT

- Led team of 4 and managed plans, materials, equipment to efficiently install automated home irrigation systems
- Operated heavy equipment such as trenchers, skidsteers and excavators safely

Volunteer and Other Experience

Church of Jesus Christ of Latter-day Saints Mar 2011 - Mar 2013
Full-time Representative Southern Italy, and Malta

- Developed leadership, training, public speaking, and managerial skills while providing full-time volunteer service
- Coordinated efforts of 26-50 volunteers spread across the regions of Calabria and Sicily

BYU Y-Serve: Self Help Homes Jan 2015 - Apr 2016
Program Director Heber City & Elk Ridge Utah

- Collaborated with constructional professionals to provide skill training to volunteers, resulting in our program's community contact receiving the Community Service Provider of the year award from BYU

Utah's Hogle Zoo Jun 2016
Animal care intern SLC, UT

- Selected as hoof-stock caretaker, responsible for husbandry of 4 giraffes, 3 zebras and 2 ostriches

Other Skills & Certifications

- Software: Basic knowledge of Autodesk's CAD and Revit, VBA Programming, Microsoft Office
- Passed Fundamentals of Engineering (FE) exam. Registered EIT

Appendix B

ASTM Test Standards for Laboratory Work

The following ASTM Standards will be followed for laboratory work:

ASTM D1883 – 16 (California Bearing Ratio)

ASTM C131 & AASTHO T96 (LA Abrasion Test)

ASTM D698 (Standard Proctor Test)

ASTM D1557 (Modified Proctor Test)

ASTM C 136 (Sieve Analysis of Fine and Coarse Aggregates)

ASTM D1074 (Uniaxial Compressive Strength of asphalt)