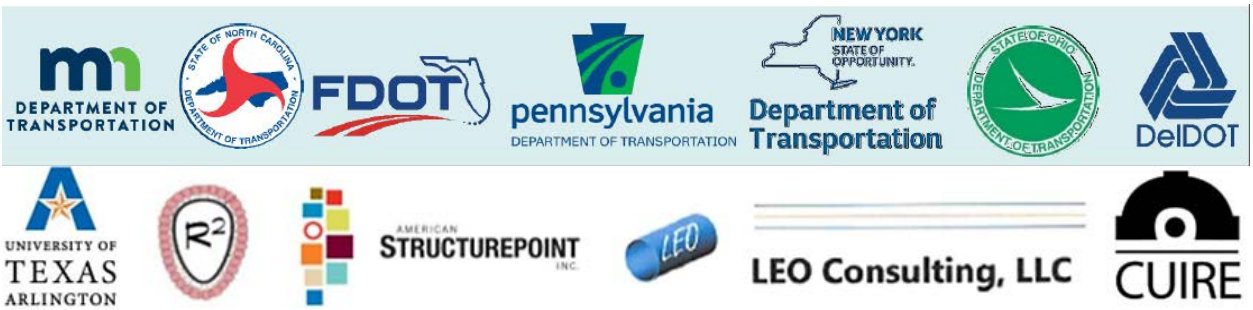


# Second Quarterly Progress Report

# ODOT Research

Second Quarter Ended on June 30
"Quarterly Report: State Job #31347"

| | |
|---|---|
| **For Quarter Ending:** | June 30 |
| **Date Submitted:** | **July 31** |

| | | | | | |
|---|---|---|---|---|---|
| **Project Title:** | Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits | | | | |
| **Research Agency:** | CUIRE/The University of Texas at Arlington | | | | |
| **Principal Investigator(s):** | PI: Mohammad Najafi, Ph.D., P.E., F. ASCE, Professor and Director, CUIRE<br>Co-PI: Xinbao Yu, Ph.D., P.E., Associate Professor | | | | |
| **State Job Number:** | 5501.03 | | Agreement Number: | | 31347 |
| **Project Start Date:** | 20 December 2017 | | Contract Funds Approved: | | 25 September 2017 |
| **Project Completion Date:** | 20 December 2019 | | Spent to Date: | | $33,327.25 |
| **% Funds Expended:** | 8.33% | % Work Done: | 19% | % Time Expired: | 25% |

List the ODOT Technical Liaisons and other individuals who should receive a copy of this report:

1. Jeffrey E. Syer, P.E. Ohio DOT
2. Brian R. Carmody, P.E. - NYSDOT
3. Matthew S. Lauffer, P.E. and Charles Smith P.E – NCDOT
4. Paul Rowekamp and Aislyn Ryan - MnDOT
5. Sheri Little, - PennDOT
6. Carlton Spirio, - FDOT
7. Jonathan Karam and Nicholas Dean - DelDOT

# Contents

# Tables

# Schedule of Research Activities Tied to Each Task Defined in the Proposal and Percentage Completion of the Research

# Table 1: SAPL Research Project Schedule

***Ohio Department of Transportation***

**Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits**

1st Quarter Dec. 20, 2017 through March 31, 2018 | 2nd Quarter April 1, through June 30, 2018

CUIRE | LEO Consulting, LLC | STRUCTUREPOINT

Project Schedule Sorted by Start date

| Task | Responsibility | Description | 2017 Dec | 2018 Jan | Feb | Mar | Apr | M* | May | Jun | Jul | M* | Aug | Sep | Oct | M* | Nov | Dec | 2019 Jan | M* | Feb | Mar | Apr | M* | May | Jun | Jul | M* | Aug | M* | Sep | Oct | Nov | Dec | M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Dr. Mo Najafi | Literature Search/Participation Material Vendors | | | | | | | | Delivered | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Dr. Mo Najafi, Dr. Xinbao Yu | Lab Testing | | | Vendor | Communication (Delivered | | | | 37.50% | | | | | | | | | | | | | Deliver-able | | | | | | | | | | | | | |
| 11- A | | Testing Coupons from Vendors | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 - B | | Data Acquisition Setup | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 - C | | Soil Box Test 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 - D | | Soil Box Test 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11- E | | Soil Box Test 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Dr. Mo Najafi | Survey of US DOT's and Canadian Agencies | | | | | | | | 71.00% | | | Deliver-able | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Mr. Ed Kampbell | Field Data Collection and Assistance from DOT Partners | | | | | | | | 40.00% | | | | Deliver-able | | | | | | | | | | | | | | | | | | | | | |
| 3 | Mr. Ed Kampbell | Additional Reinforcement | | | | | | | | 67.00% | Deliver-able | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Mr. Ed Kampbell | Evaluation if Corrugations Needed to be Completely Filled by the Spray Applied Liner as Part of the Structural Design | | | | | | | | 67.00% | Deliver-able | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Dr. Mo Najafi | Life Cycle Cost Analysis | | | | | | | | | | | | | Deliver-able | | | | | | | | | | | | | | | | | | | | |
| 6 | Mr. Ed Kampbell | Review the Cured In Place (CIPP) Design Equations | | | | | | | | | | | | | Deliver-able | | | | | | | | | | | | | | | | | | | | |
| 8 | Dr. Firat Sever | Develop a Recommended Structural Design Equations | | | | | | | | | | | | | | | | | Deliver-able | | | | | | | | | | | | | | | | |
| 8 - A | | Establish base equations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 - B | | Identify missing parameters | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 - C | | Revise equations with field and lab data | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 - D | | Verify and finalize equations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Dr. Xinabo Yu | Computational Modeling | | | | | | | | 37.50% | | | | | | | | | | | | | Deliver-able | | | | | | | | | | | | |
| 10 - A | | Create and Verify Circular Reinforced Concrete Pipe W/O Liner W/O Crack in Granular Soil | | | | | | | | 83.00% | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 - B | | Evaluate FEM Models with Design Equations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 - C | | Calibrate FEM Models with LAB Tests | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 - D | | Parametric Study of FEM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Dr. Firat Sever, Mr. Ed Kampbell | Develop Performance Construction Specification | | | | | | | | | | | | | | | | | | | | | | | Deliver-able | | | | | | | | | | |
| 9 - A | | Prepare Draft Specs for Polymeric Spray Applied Liners | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 - B | | Prepare Draft Specs for Cementitious Spray Applied Liners | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 - C | | Prepare Final Specs for Polymeric Spray Applied Liners | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 - D | | Prepare Final Specs for Cementitious Spray Applied Liners | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Dr. Mo Najafi | Draft Final Report and Fact Sheet | | | | | | | | | | | | | | | | | | | | | | | | | | | Deliver-able | | | | | | |
| 14 | Dr. Mo Najafi | Final Report and Presentation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Final Report | | | | |
| 12 | Mr. Lynn Osborn | QA/QC | | | | | | | | 29.20% | | | | | | | | | | | | | | | | | | | | | | | | Deliver-able | |

Quarterly Progress Report (April 30, 2018) | Quarterly Progress Report (July 31, 2018) | Quarterly Progress Report (October 30, 2018) | Quarterly Progress Report (January 30, 2019) | Quarterly Progress Report (April 30, 2019) | Quarterly Progress Report (July 31, 2019) | Draft Final Report and Draft Fact Sheet (August 20, 2019) | Draft Report Review (Due September 30, 2019) | End of Project (December 20, 2019)

* Milestone

Second Quarter Progress Completed Percentage

Laboratory Testing Was Transferred to NTPEP

**Table 2: Completion Percentage of SAPL Research Project Tasks over the 1st and 2nd Quarter**

| Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits | | | |
|---|---|---|---|
| CUIRE LEO LEO Consulting, LLC R2 AMERICAN STRUCTUREPOINT INC | | | |
| **Task Number** | **Task Description** | **Percentage Completed at the End of 1st Quarter** *Dec 2017 through March 2018* | **Percentage Completed at the End of 2nd Quarter** *April through June 2018* |
| **1** | Survey of US DOT's and Canadian Agencies | 29% | 71% |
| **2** | Literature Search/Participation Material Vendors | 57% | 100% |
| **3** | Additional Reinforcement | 0% | 67% |
| **4** | Evaluation if Corrugations Needed to be Completely Filled by the Spray Applied Liner as Part of the Structural Design | 0% | 67% |
| **5** | Life Cycle Cost Analysis | 0% | 0% |
| **6** | Review the Cured in Place (CIPP) Design Equations | 0% | 0% |
| **7** | Field Data Collection and Assistance from DOT Partners | 0% | 40% |
| **8** | Develop a Recommended Structural Design Equations | 0% | 0% |
| **9** | Develop Performance Construction Specification | 0% | 0% |
| **10** | Computational Modeling | 19% | 38% |
| **11** | Lab Testing | 19% | 38% |
| **12** | QA/QC | 17% | 29% |

# Comparative Status of Actual Versus Estimated Expenditures

## Table 3: 2nd Quarterly Progress Work of SAPL Research Project

| Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Quarterly Progress Work** | | | | | | | | |
| **Task Number** | **Task Description** | **Total Duration (Months)** | **Duration Completed (Months)** | **Budgeted Amount ($)** | **Percentage of Completed Based on Schedule (%)** | **Percentage of Total Based on Budget (%)** | **Percentage Completed This Quarter (%)** | **Actual Amount Completed This Quarter ($)** |
| **1** | Survey of US DOT's and Canadian Agencies | 7 | 5 | $25,751 | 71.00 | 6.44 | 85.00 | $21,888 |
| **2** | Literature Search/Participation Material Vendors | 7 | 7 (Completed) | $21,875 | 100.00 | 5.47 | 100.00 | $21,875 |
| **3** | Additional Reinforcement | 3 | 2 | $2,100 | 67.00 | 0.52 | 67.00 | $1,407 |
| **4** | Evaluation if Corrugations Needed to be Completely Filled by the Spray Applied Liner as Part of the Structural Design | 3 | 2 | $3,900 | 67.00 | 0.97 | 67.00 | $2,613 |
| **5** | Life Cycle Cost Analysis | 3 | Not Started | $29,123 | 0.00 | 7.28 | 0.00 | $0 |
| **6** | Review the Cured in Place (CIPP) Design Equations | 3 | Not Started | $13,751 | 0.00 | 3.44 | 0.00 | $0 |
| **7** | Field Data Collection and Assistance from DOT Partners | 5 | 2 | $26,752 | 40.00 | 6.69 | 40.00 | $10,701 |
| **8** | Develop a Recommended Structural Design Equations | 5 | Not Started | $34,081 | 0.00 | 8.52 | 0.00 | $0 |
| **9** | Develop Performance Construction Specification | 7 | Not Started | $27,392 | 0.00 | 6.85 | 0.00 | $0 |
| **10** | Computational Modeling | 16 | 6 | $52,039 | 37.50 | 13.01 | 10.00 | $5,204 |
| **11** | Lab Testing | 16 | 6 | $67,001 | 37.50 | 16.75 | 15.00 | $10,050 |
| **12** | QA/QC | 24 | 7 | $8,000 | 29.20 | 2.00 | 29.20 | $2,336 |
| **13** | Draft Final Report and Fact Sheet | 7 | Not Started | $88,270 | 0.00 | 22.07 | 0.00 | $0 |
| **14** | Final Report and Presentation | 3 | Not Started | | | | | |
| Total | | | | $400,034 | | 100.00 | | $76,074 |

**Table 4: Expenditures Summery of SAPL Research Project in 2nd quarter**

| Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits | |
|---|---|
| **Summary of Expenditures for 2nd Quarter (April through June 2018)** | |
| **Description** | **Sum Amount** |
| **Salaries and Benefits** | |
| Faculty Salaries and Benefits | $12,100.40 |
| Student Salaries and Benefits | $8,694.43 |
| **Partner Companies** | |
| Leo Consulting | $1,900.00 |
| Rehabilitation Resource Solutions, LLC | $6,075.00 |
| **Equipment** | |
| OLYMPUS 38DL PLUS Ultrasonic Thickness Gage | $4,179.42 |
| 4” Z1 CORE DRILL MACHINE | $378.00 |
| **Material** | |
| N/A | $0.00 |
| **Total** | **$33,327.25** |

# Brief Description of the Activities Accomplished by Each Member of the Research Team as Listed in the Project Budget

## Principal Investigator: Dr. Mohammad Najafi

**Task 1: Survey of U.S. DOTs and Canadian Agencies.**

- Continued to gather information from U.S. DOTs and Canadian Agencies by following up on the survey
- Analyzed survey responses and prepared a preliminary report

**Task 2: Literature Search/Participation Material Vendors.**

**Literature Review (Delivered).**

- Created a Microsoft Access Database, an interactive depository of literature studies for SAPL Research Project.

**Participation of Material Vendors (Delivered).**

**Task 7: Field Data Collection and Assistance from DOT Partners.**

- Prepared Job Site Visit Plan with the help of information provided by the DOTs.
- The Job Site Visit Plan included location of the sites, drawings, equipment requirements, and modified NASSCO'S PIPELINE ASSESSMENT & CERTIFICATION PROGRAM (PACP) © tables, that will be used during inspection of Culverts on site.
- Scheduled Job Site Visit Plan in coordination with Mr. Kampbell and partners DOTs.

**Task 11: Laboratory Testing.**

**Soil Box Testing.**

- Developed the detailed Soil Box Testing Plan using CMP as the host pipe per ASTM Standards and AASHTO LRFD Design and Construction Specifications.
- Ordered actuator from MTS
- Procured loading frame from Lane Supply, Inc.

**Participation in the Meetings during Conferences, Internal Meetings, Progress Meetings.**

- Attended the 3 monthly progress meeting with DOTs
- Held internal meetings with CUIRE Team research partners (Xinbao Yu, Ed Kampbell, Lynn Osborn, and Firat Sever).

## Co-Principal Investigator: Dr. Xinbao Yu

The following are the tasks performed this quarter:

**Task 2. Literature Review.**

- Reviewed ASTM standards D1556, D2167, D6938 to choose appropriate methods to measure field compaction.
- Recommended using nuclear density gauge following the procedure in ASTM D6938 to measure field compaction during soil box test.
- Reviewed papers on previous works relating to pipe-soil interactions.
- Reviewed papers on effects of burial depth on culvert or pipe.
- Reviewed different papers and AASHTO LRFD Bridge Design Specifications to obtain information about the present methodology in the design of buried pipes and culverts.
- Revised calculations on load distribution from the load pad to top of culvert without accounting for pavement.
- Revised bearing capacity calculations to show the bearing capacity of the soil for various combination of load pad sizes and soil properties.
- Reviewed literature to check for the suitability of TDR (Time Domain Reflectometry) to measure soil compaction/density of soil box.

**Task 11. Laboratory Testing.**

**a) Soil Box Test Plan.**

- Discussed the merits/demerits of longitudinal vs. lateral pipe layout for soil box test. Recommended longitudinal layout.
- Prepared and revised design drawings of soil box tests.
- Prepared section and plan views of test setups for both circular pipes and pipe arch in a longitudinal arrangement, separated by wooden walls.
- Prepared drawings of alternatives for different combinations: longitudinal/lateral test setup and 48-in. or 60-in. pipe diameter along with load path for service and ultimate load conditions. Recommended using 60-in. pipes, laid out longitudinally along the soil box.
- After the internal meeting with research partners, revised test setup drawings removing the unnecessary partitions to simplify the test setup.
- Made drawings for two possible testing options- cutting the invert of host pipe or making cuts along the host pipe section before lining.
- Revised the drawings to depict cutting approximately 2-ft. of invert of both circular and arch host CMPs after meeting with DOTs.
- Prepared drawings depicting testing steps to perform control tests on host CMPs for both service and ultimate load conditions.
- Prepared drawings of test setup for control test on host CMPs (both circular and arch).

- Prepared final drawings for soil box tests of 48-in' diameter circular pipes and 71-in.X 47-in. pipe arch based on an agreed upon test setup.

**b) Soil Compaction Plan.**

- Reviewed and discussed soil compaction plan.
- Reviewed current soil compaction methods for storm water conduits construction.
- Reviewed current lab and field measurement of soil density and moisture.
- Tested and evaluated several candidate backfill soils (SP, GP) as backfill.
- Recommended using Vibratory Table test to determine maximum dry density in laboratory of backfill soil.
- Recommended final backfill soil (mixture of sand and gravel (GP-SP)), compaction method (vibratory plate), and measurement method (TDR).

**c) Instrumentation.**

- Recommended reducing the number of instrumented sections to reduce instrumentation cost.
- Revised number of instrumentations required based on reduced test section.
- Obtained updated quotes from vendors for different instruments.
- Recommended using Cable Displacement Sensors as opposed to Convergence Meters due to problems in installing Convergence Meter.
- Finalized number of instrumentations for one test section, directly below the load pad.
- Made purchase order for Strain Gauges from TMI.
- Inquired with GeoKon regarding the possibility of refurbishing Earth Pressure Cells present in CUIRE.
- Checked for rental and purchasing options for Nuclear Density Gauge. Recommended rental option as the more suitable for us.
- Contacted nuclear density gauge suppliers/testing labs to determine calibration requirements and necessary licensing procedure to rent/purchase the equipment.
- Proposed using TDR as the method to measure soil compaction in soil box over nuclear density gauge.

**Task 10. Computational Modelling.**

- Modeled soil compaction in CURIE soil box test setting and verified with steel pipe data available from previous CURIE soil box test results.
- ABAQUS FEM model depicting soil box test of steel pipe performed previously at CUIRE.
- Used pipe deflection data presented in the report to validate the modeling approach.
- Prepared a report detailing the FEM modeling of steel pipe buried in soil.

## Subcontractor: Mr. Ed Kampbell
## Rehabilitation Resource Solutions, LLC

**Task 3 – Additional Reinforcement.**

A literature search was completed regarding applicable reinforcement materials for thin shell concrete structures, which is what pipe linings are. The review considered all forms of ferrous and non-ferrous reinforcement materials, micro-fibers, macro-fibers, meshes, and reinforcing rods. The conclusions of the report stated that there were alternatives to adding additional reinforcement to a thin-shell liner if required by the site-specific design. These included macro-fibers for long-term shrinkage cracking, shear strength, and post-fracturing residual bending strength. Further, the use of non-metallic meshes such as those made from basalt fibers could be employed to increase the liner's modulus of rupture. This report was essentially complete as of June 30 and given to CUIRE for their review.

**Task 4 – Evaluation of Needs to Fill the Corrugations.**

This report was also essentially complete as of June 30 and given to the CUIRE for their review. The report viewed the filling of the corrugations based on constructability, hydraulic performance, structural performance, and operation and maintenance performance. The report concluded that filling of the corrugations first and then applying the "structural portion of the liner" above the crests of the corrugations was indeed in the DOT's best interest. Following the corrugations for the 2⅔×½-in. and 3×1-in. profiles was very un-constructible; and following the corrugations for the 6×2-in. profile was very impractical. Further, the filling of the corrugations had the very positive benefit of bringing the neutral axis away from the inner wall surface thereby decreasing the flexural stress at the inner surface of the lined pipe. Beyond the positive benefits of increasing the hydraulic capacity of culverts operating in outlet control, a relatively smooth interior would minimize debris buildup and potential damage from large rocks passing through the culvert.

**Task 7 – Field Data Collection.**

In the second quarter, I began to pick the best culvert installations to represent applications that would provide insight into the liner's design performance and specifications needed to assure those designs were carried out. The CUIRE disagreed with some of those choices and asked me to go with smaller pipes. Ultimately, CUIRE and the DOTs gravitated to the pipes that I felt were the best representatives for our project's goals. As of June 30, this selection process was still ongoing. What has emerged on this portion of the project is that each DOT wants us to visit at least one pipe in their state; swelling the number of site visits to 21 locations. This will require an increase in the budgeted hours of almost 50%; and an increase in travel expenses of almost 30%. We are now awaiting the DOT's decision on this increase.

**Task 11 – Soil Box testing.**

Per the project team's leader, I participated in numerous meetings regarding the configuration of the soil box testing. This included conversations with the liner material suppliers as to what they would be willing to see the CUIRE in constructing SAPLs inside of either a Sonotube or a CMP. There seems to be a lot of concern with the sizing of the soil box and the proposed sizes of pipes to be tested. To my knowledge, discussions are still ongoing as to what route will be taken.

## Subcontractor: Dr. Firat Sever
## American Structurepoint, Inc.

Subcontractor American Structurepoint, Inc. /Dr. Firat Sever has performed the following tasks in the 3rd quarter:

- Attended periodic conference calls with the CUIRE.
- Completed subcontracting with American Structurepoint.
- Reviewed ASI tasks and prepared a short-term work plan for Karen Saavedra, PE.

**Task 11 Laboratory Testing.**

- Reviewed soil box test plan.

**Task 2 Literature Review.**

- Conducted literature review.

**Task 8 Develop a Recommended Structural Design Equations.**

- Identified some of the base design equations (ongoing).

## Subcontractor: Mr. Lynn Osborn
## LEO Consulting, LLC

**Task 12. QA/QC.**

As QA/QC Reviewer, much of my work depends upon the work and progress of other team members. Following is a summary of progress for Q2, 2018:

1. The customer must be involved in the design & development process. This occurred during a conference call with ODOT on May 3.
2. Reviews must be conducted to evaluate the ability of the results to meet the requirements. This occurred during internal conference calls on May 1, May 2 and June 26.
3. For general project oversight, reviews were conducted on the Site Visit Plan, Soil Box Testing Plan, Literature Review, Task 3 Document, Task 4 Document and Soil Box Testing Alternatives.

# Proposed Work for New Quarter

**Table 5: SAPL Research Project Tasks for 3rd Quarter (July 1 through September 30)**

| Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits | | | | | |
|---|---|---|---|---|---|
| CUIRE LEO LEO Consulting, LLC R2 AMERICAN STRUCTUREPOINT INC. | | | | | |
| **Task Number** | **Responsibility** | **Task Description** | **Percentage of Work to Be Completed by the End of 3rd Quarter** | | |
| | | | **July 1th through September 30th** | | |
| | | | **July** | **August** | **September** |
| 1 | Dr. Mo Najafi | Survey of US DOT's and Canadian Agencies | | To Be Delivered | -- |
| 3 | Mr. Ed Kampbell | Additional Reinforcement | To Be Delivered | -- | -- |
| 4 | Mr. Ed Kampbell | Evaluation if Corrugations Needed to be Completely Filled by the Spray Applied Liner as Part of the Structural Design | To Be Delivered | -- | -- |
| 5 | Dr. Mo Najafi | Life Cycle Cost Analysis | -- | To Be Started | |
| 6 | Mr. Ed Kampbell | Review the Cured In Place (CIPP) Design Equations | -- | To Be Started | |
| 7 | Mr. Ed Kampbell | Field Data Collection and Assistance from DOT Partners | -- | To Be Started | |
| 8 | Dr. Firat Sever | Develop a Recommended Structural Design Equations | -- | | To Be Started |
| 9 - A | Dr. Firat Sever<br>Mr. Ed Kampbell | Develop Performance Construction Specification<br>Prepare Draft Specs for Polymeric Spray Applied Liners | -- | | To Be Started |
| 10 | Dr. Xinabo Yu | Computational Modeling | To Be Continued | | |
| 11 | Dr. Mo Najafi<br>Dr. Xinbao Yu | Lab Testing | To Be Continued | | |
| 12 | Mr. Lynn Osborn | QA/QC | To Be Continued | | |

## Principal Investigator: Dr. Mohammad Najafi

- Submit papers to No-Dig Show, TRB, ASCE Pipelines
  - Present at the Advancing Hydraulic Engineering through Innovation and Resilient Design (2018) NHEC Conference

**Task 1: Survey of U.S. DOTs and Canadian Agencies.**

- Complete survey analysis and finalize the report.

**Task 5: Life Cycle Cost Analysis.**

- Start life cycle analysis.

**Task 11: Soil Box Testing.**

- Start Soil Box Testing.

## Co-Principal Investigator: Dr. Xinbao Yu

**Planned Task for the Next Quarter.**

- Preparation of soil box test
- Soil box test of host CMP pipes
- FEM model of CMP host pipe in the soil box

## Subcontractor: Mr. Ed Kampbell
## Rehabilitation Resource Solutions, LLC

**Task 3 – Additional Reinforcement.**

- Final adjustments will be made to the report based upon the comments received from the DOT's review of the submitted report.

**Task 4 – Evaluation of the Need to Fill the Corrugations.**

- Final adjustments will be made to the report based upon the comments received from the DOT's review of the submitted report.

**Task 6 – Review the CIPP Design Equations.**

- The report on the review of how CIPP is designed is due by the end of October. My workload permitting, I will plan on being essentially complete with this review by the first week in October.

**Task 7 – Field Data Collection.**

- Based upon the outcome of the DOT's to grant our request for a budget increase for this work, we are scheduled to visit all 21 of the requested installations beginning on July 23 and ending on August 18. We are planning to break the inspection down into three trips. This schedule will be essential to our meeting the CUIRE proposed deadline of writing up our inspections by mid-September.

**Task 9 – Develop Performance Construction Specifications.**

- A draft performance specification will be developed for; (1) polymeric sprayed in place liners and (2) cementitious sprayed in place liners. These drafts are shown to be done by the end of October.

## Subcontractor: Dr. Firat Sever
## American Structurepoint, Inc.

**Task 8. Develop a Recommended Structural Design Equations.**

The following tasks are to be performed by American Structurepoint, Inc. / Dr. Firat Sever in the next quarter:

- Continue on identifying existing equations in relevant design and literature review.
- Coordinate ASI tasks with respect to design equations and technical specifications development.
- Communicate with manufacturers and other design engineers in the industry on the design equations they use for SAPLs.
- Prepare tables of physical and mechanical properties of cementitious and polymeric SAPLs based on third party data. (Utilize the WERF project data acquired by the project team previously.)
- Attend periodic team conference calls (internal).

## Subcontractor: Mr. Lynn Osborn
## LEO Consulting, LLC

**Task 12. QA/QC.**

- QA/QC reviews will continue on design and development planning, inputs and control. This will include general project oversight as required.

## Implementation (if any):

N/A

## Problems & Recommended Solutions (if applicable):

N/A

## Equipment Purchased (if any):

- OLYMPUS 38DL PLUS Ultrasonic Thickness Gage
- 4” Z1 CORE DRILL MACHINE

# Contacts and Meetings

## Progress Meeting

**Table 6: SAPL Progress Meeting during 2nd Quarter (April 1 through June 30)**

| No. | Progress Meeting Agenda | Date |
|---|---|---|
| **3** | • Schedule<br>• Survey<br>• DOT SAPL Past Project Summary<br>• Vendor Communications<br>• Soil Box Testing | April 10, 2018 |
| **4** | • Schedule Update<br>• Preliminary Survey Results<br>• DOT SAPL Past Project Summary<br>• Soil Box Testing Details<br>• First Quarterly Report<br>• Vendor Communications for Soil Box Testing | May 8, 2018 |
| **5** | • Schedule Update<br>• Tentative SAPL Jobsite Visit Plan and Inspection Protocol<br>• SAPL Soil Box Testing Plan<br>• Draft Survey Results<br>• Draft Literature Review | June 12, 2018 |