Enterprise Program
Michigan Technological University

Project Summary

Exhibit A

Project Title: Transmission Line Structure Alternative Foundation Construction Methods

Sponsor: American Transmission Co. (ATC)

Enterprise Team: Consumer Product Manufacturing

Faculty Advisor: Dr. Tony Rogers; tnrogers@mtu.edu

Start Date: 9/5/2017 **End Date: 5/4/2018**

Sponsorship Fee: $17,500 **Sponsorship Type: Restricted**

Background & Overview

American Transmission Co. (ATC) was founded in 2001, as the first multi-state, transmission-only utility in the United States. Unlike most other utilities, ATC has a single focus – transmission of electric power from where it's generated to where it's needed. ATC's coverage area includes over 9,400 miles of high voltage transmission lines and more than 500 substations throughout the Upper Peninsula of Michigan, the eastern half of Wisconsin, and into portions of Illinois and Minnesota.[1]

ATC's new high voltage transmission line designs typically consist of large steel monopoles or wood pole timber-framed structures (both monopoles and H-frames). These structures vary in size; however, they tend to be tall and slender in nature, and thus they can produce large overturning moments at the base. For this reason, deep foundations are required in many steel pole design instances to support the structure.

ATC utilizes two main deep foundation types: drilled concrete piers and steel vibratory caissons. The drilled concrete pier method involves the installation of a large-diameter drilled shaft requiring the use of large and heavy drilling and installation equipment. ATC is accustomed to this method of foundation construction and often specifies it, regardless of the soil conditions. Construction crews are often required to drill into bedrock, clay, or saturated soils which can lead to unforeseen costs that account for project overruns. These overruns can total six figures or more depending on project scale.

ATC also is now installing vibratory caissons with tangent (non-angle) steel structures of limited size. This method utilizes a steel pole with a uniform cross-section throughout its length, rather than a drilled concrete pier, to support the structure. The pole is driven into

the soil using high-frequency, low-amplitude vibration until the pole reaches the required depth. After the pole is installed, the structure is attached to the mounting plate with bolts. This method has proven to be very cost-effective, but is not suitable for all soil conditions.

Problem/Opportunity Statement

In many cases, transmission line support structures are located in remote areas making them difficult to access. Furthermore, soil conditions (i.e. bedrock, clay, etc.) and associated geotechnical properties can vary greatly from structure to structure. An opportunity exists for a team to improve upon ATC's current foundation specification approach by investigating alternative methods for supporting transmission line structures that will accommodate this variance in soil condition and accessibility.

Project Significance

An alternative method to foundation construction can greatly help reduce cost and time associated with installation of foundations in poor/unexpected soil conditions.

Illustration, Drawing, Image, or Graphic Describing the Project

Figure 1: Drill Shaft Foundation Used by ATC

Figure 2: Steel Transmission Line Support Structure

Anticipated Outcomes of the Student Team

- Background: Discuss the current foundation construction method(s) with ATC and determine base line requirements for foundation installation and visit a proposed transmission line support structure site.
- Investigate: Investigate multiple alternative construction methods considering the requirements defined during the background phase. Present the findings to the sponsor.
- Select: Using a Pugh Matrix or similar method to determine one foundation construction method considering cost, constructability, grounding, and corrosion.

- Design: Based upon sponsor agreement, design the chosen concept considering conditions as defined by the sponsor considering all applicable codes and regulatory agency requirements. Create a construction plan set for chosen concept using a CAD software package.

- Estimate: Create an "Engineers Opinion of Probable Cost" estimate using current unit prices and expected quantities for the designed concept.

- Construction specifications: Create information in support of a technical specification for construction documenting all material requirements, construction methods, and applicable regulatory standards.

- Documentation: Prepare a comprehensive project report with all technical information, calculations, models, data sets, results, and future recommendations. Deliver a final presentation to the sponsor and present your project at Design Expo.

Key Functional Requirements of the Material, Product, Process, or System

- The team should consider whether a specialty contractor will be required to perform the work for the chosen concept.

- The team should consider availability of materials in the Northern Wisconsin and Upper Michigan areas.

Special Notes

- The student team may be required to travel to a project site located within the Upper Peninsula as designated by ATC.

Sponsor Contact Information

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Sponsor to Provide

- Sponsorship funding for the Enterprise program and the student project team.
- Regular interaction with the student team via tele/video conference (weekly).
- Technical guidance as needed.
- Access to relevant background information such as CAD drawings, construction specifications, and ATC specific regulations.
- Timely feedback and approval of technical objects, concepts, and presentations/reports.

Michigan Tech to Provide

- A multi-year, multi-disciplinary team of undergraduate students potentially including students majoring in civil (structural/geotechnical) engineering and/or electrical engineering who are enrolled in the Enterprise program.
- Faculty advising support.
- Team access to a portion of the program sponsorship fee for direct project related expenses and sponsor approved travel.
- Team access to Michigan Tech design software, labs, and fabrication facilities.
- Regular progress updates.
- A comprehensive final report including all technical information, models, drawings, calculations, data sets, results, and future recommendations.
- A comprehensive final presentation.

Reference 1: ATC Website: http://www.atcllc.com/about-us/ (2017-07-13)