

**COMPARISON OF HSS SECTIONS
ROUND, SQUARE, RECTANGULAR, AND
TRIANGULAR OF SIMILAR MASS**

Project ID: CEEEn_2017CPST_009

by

MSW Engineers

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A Capstone project submitted to:

American Tubular Products,

a Division of Schaeffer Industries

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

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Introduction

PROJECT TITLE: HSS Triangular Section Evaluation

PROJECT ID: CEEEn-2017CPST-009

PROJECT SPONSOR: American Tubular Products (“ATP”), a Division of Schaeffer Industries

TEAM NAME: MSW Engineers

The objective of this project is to conduct comparison testing to determine the differences in traditional HSS sections (round, square, and rectangular) to a triangular HSS section of similar mass. In order to accomplish this objective, our team will conduct a finite element analysis on each shape in order to gain a base expectation of potential abnormalities and where key data points will likely be on elements tested in the lab.

Destructive testing will be conducted to assess the load resistance and load bearing capabilities as well as torsion and twist resistance. Tensile tests will also be performed on sections to determine what impact the induction welding process has on the steel. Testing will include tensile testing of “dog-bone sectioned” areas parallel and perpendicular to the weld. Torsion tests will have one end fixed with the twist on the free end. Buckling tests will be done using an axial load without lateral bracing. Bending tests with center loading on a fixed-fixed configuration as well as a cantilever condition with the load placed on the free end. Shear tests will be performed on all cross sectional shapes.

Each week ATP will receive status reports discussing overall progress with information regarding challenges and solutions. A presentation and electronic final report will be provided at the conclusion of the project.

Schedule:

Fall Semester 2017:

We will begin the calculations and modeling for determining potential strengths and failures of different test applications. By the end of 2017, we will have an expectation of how traditional HSS sections (round, square, and rectangular) will compare to a triangular HSS section of similar mass.

Winter Semester 2018:

Calculations, modeling, and testing will be completed. Calculations have already begun and are expected to be completed by the new year, the modeling will begin at the beginning of January and will be completed by February 15th, and testing will begin no later than February 1st and be completed by March 1st. Our weekly updates will include details on these tasks. From the results obtained we will be able to assess the viability of the triangular HSS section compared to traditional HSS sections (round, square, and rectangular). A report of our findings will be prepared no later than April 1st.

Proposed Work Plan

Our team will perform tensile, torsion, buckling, bending, and shear tests on steel tubes provided by ATP. We will perform tensile tests on the welded dog-bone sections of all shapes. These tensile tests will be using sections both parallel and perpendicular to the weld resulting in a total of 40 dog bone sections with 5 parallel and 5 perpendicular sections for each shape. The torsion tests will have one end fixed and a twisting force applied to a fixture on the free end. Our initial cost estimate is assuming that the tubes will arrive with fixtures attached at the centroid of the cross sectional area for the torsion tests. Lengths for the torsion test members will be determined pending torsion test equipment discussion. The buckling tests will be performed on 9 foot sections without lateral bracing. Bending tests will be performed on 10 foot sections that are fixed at both ends with in the center as well as 5 foot sections that are fixed at one end with free end loading. Each test will be done 5 times. These tests will be performed at the BYU Structures Lab, testing will begin winter semester 2018. A list of materials to be provided to ATP. Upon completion the test results will be presented to ATP.

Schedule

The three senior students will meet on a weekly basis to discuss and perform modeling and calculations of the tests that will be performed in the 2018 Winter semester. We will be working with Dr. Wayne Lee assisting with finite-element modeling and Dr. David Jensen for project guidance on how to achieve accurate results.

During the winter semester of 2018 we will provide weekly progress reports noting our major achievements and partial results. These partial results will be revised and communicated with our outside consultants as well as shown in our weekly reports to ATP.

The three senior students will meet twice a week to meet our objectives. We will review the results and discuss how the objectives of this project have been met and how to proceed to meet all objectives of this project.

By the beginning of April 2018 we will have performed all of our material testing, and will have obtained our results to provide reliable comparisons among round, square, rectangular, and triangular HSS sections. The results provided to ATP will be provided in a presentation as well as an electronic report. ATP will also be given the final results for their personal comparisons and files.

Facilities, Tools, Data and Equipment

During the fall 2017 semester we will begin performing finite element analysis using a model developed by Dr. Wayne Lee. This program along with other calculations will guide our group in knowing what to expect during testing.

ATP will provide the necessary cross sections that will be required for testing. The BYU Structures Lab led by Dave Anderson (Lab Manager) will be providing a suitable facility with the equipment required to perform the various tests on the provided sections.

Project Budget

To be completed by Dr. Lee and Dave Anderson

Deliverables

ATP will receive a short weekly status report addressing work completed in the previous month. This report will discuss the challenges the team has encountered as well as what action has been taken to overcome those challenges. The overall progress that has been made as well as progress with specific challenges from prior updates will be provided. A general status report will be included with updated schedules as necessary.

A final report containing our findings will be compiled and presented in an electronic format to ATP in April 2018. The final report will include data collected from the various tests specified in the proposed work plan, performance of the various cross sectional shapes will be compared to assess the viability of a triangular cross section. A presentation summarizing our project will also be presented to ATP. Presentations excluding proprietary information (such as shapes) will be presented to BYU students, faculty and other interested individuals.

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

Key Personnel:

Sponsor: American Tubular Products, a Division of Schaeffer Industries
Sponsor Representative: Graham Bilson, Manager - Engineering & Tooling

Outside Consultants:

Faculty Advisor: Dr. David W. Jensen
Civil Engineering Lab manager: Dave Anderson
Graduate Student Advisor: Daniel Schwicht
Capstone Instructors: Dr. Wayne Lee and Dr. M Brett Borrup

Team Members:

Nathan Wainwright - Team Leader
Christopher Macias - Project Development
Nicholas Smith - Project Development

Our team is comprised of three senior Brigham Young University Civil Engineering Students. We have taken a variety of classes in statics, materials, structural analysis, and project management. These skills in conjunction with the assistance of our outside consultants will provide a strong basis for accomplishing the objectives of this project. The outside consultants will help us remain on task and help us predetermine potential hazards during testing. The senior BYU students will be responsible for performing pre-test calculations, modeling, and testing.

Appendix A

DANIEL SCHWICHT

dewschwicht@gmail.com | 385.204.3852

EDUCATION

- Civil Engineering Master of Science (Anticipated) June 2018
Brigham Young University, mentored by Dr. Kyle Rollins
- Civil Engineering Bachelor of Science June 2017
Brigham Young University; 3.01 GPA

RELEVANT EMPLOYMENT

- High-speed Rail Abutment Graduate Research Assistant 2017 - present
Brigham Young University, mentored by Dr. Kyle Rollins
 - Organized and reported data for large-scale testing of earthquake loading of abutment
 - Reported findings for immediate implementation by Caltrans
- Materials Testing Technician 2016
RBG Engineering; Provo, UT
 - Performed gradations (grain size), field and lab concrete tests, nuclear densometer tests, asphalt burn and rice tests, Atterbergs, etc.
 - Trained new employees in ASTM standards and lab and field procedures
- Geotechnical Engineering, Materials Testing, and AutoCAD Intern 2013 - 2015
Hattenburg Dilley & Linnell Engineering Consultants; Anchorage, AK
 - Worked in certified lab, geotechnical drilling, and in field
 - Corrected and verified drawings in Autodesk, ArcGIS

VOLUNTEER AND LEADERSHIP EXPERIENCE

- Full-time Religious and Service Missionary 2010 - 2012
Baltimore, MD
 - Two full years of unpaid, voluntary service
 - Developed contacts by word of mouth and referrals
 - Taught, sought out and performed community service
 - Trained other missionaries in teaching, contacting, etc.

AWARDS AND ACCOMPLISHMENTS

- Benjamin B. Talley engineering scholarship 2014
Society of American Military Engineers, Anchorage Alaska chapter
- Eagle Scout 2009
Boy Scouts of America, Great Alaska Council
 - Coordinated Eagle Scout service project landscaping at Blood Bank of Alaska
 - Organized and directed over 500 man hours of service and solicited donations of construction materials and food

SKILLS AND CERTIFICATIONS

- Professional experience with Autodesk, ArcGIS, Excel, Word, and some Visual Basic (VBA)
- Troxler Nuclear Gauge Operator certified, HAZMAT certified, 2013
- American Concrete Institute (ACI) Concrete Strength Testing certified, 2013
- ACI Concrete Field Testing certified, 2013
- Spanish translation experience, 2010 - 2012

Christopher Macias

(347) 205-2699 | 111 South 1000 East Apt. 3, Provo, Utah 84606 | chris59mac@gmail.com

EDUCATION:

Brigham Young University- Provo, Utah (Anticipated Graduation June 2018)
Bachelor of Science in Civil Engineering – Structural Emphasis
GPA: 3.33

SKILLS & QUALIFICATIONS:

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- Proficient in AutoCad, minor knowledge of Revit
 - Skilled in Microsoft Office (Word, Excel, and PowerPoint)
 - Competent in engineering software (Strucalc, Eneercalc, RetainPro, Forte, ACI 318-14)
 - Time management and project management

CIVIL ENGINEERING EXPERIENCE:

LEI Engineering & Surveying- Spanish Fork, Utah April 2016-Current
Structural Engineer Intern

- Structural analysis and review of light framed wood structures in compliance with 2015 IBC
- Experience with steel and reinforced concrete design of beams and columns
- Detailing of special connections using AutoCad and hand sketches
- Creative thinking to create the most economical and workable designs
- Learned to work in a team environment consulting with others on ideas for projects
- Time management of multiple projects to achieve set deadlines

George Transue Contracting- Stroudsburg, Pennsylvania Summer 2011

- Worked with commercial and residential projects for roof/gutter installation and roof insulation
- Team oriented environment

Landscaping- Stroudsburg, Pennsylvania Fall 2009- August 2011

- Experience with tree cutting and residential landscaping
- Involved in the building and installing of elementary school benches

ADDITIONAL EXPERIENCE:

BYU Outdoors Unlimited- Provo, Utah December 2013-2016
Student Manager

- As a student manager I was responsible for scheduling monthly work schedules. I was able to develop good time management and planning skills by making sure shifts were always full and that work shifts did not interfere with the school schedule of the employees. I was also responsible for any problems that occurred with customers while at work. I learned to resolve issues with unsatisfied customers and turn bad experience into a good one.

EFY (Especial for Youth) - Virginia June-August 2014
Youth Counselor

- As a counselor I advised and encouraged youth to be the best they can in life. I was able to learn how I too could better my life choices. What I took away from this experience is that there is always something to be learned. One is never done learning.

VOLUNTEER EXPERIENCE:

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- 2-year mission for The Church of Jesus Christ of Latter-Day Saints
 - Habitat for Humanity
 - BYU student bike repair events

References available upon request

Nicholas Smith

925-628-8363

54clipper@gmail.com

Education

BS Civil Engineering (Graduating April 2018)

Brigham Young University

Technical Skills

Microsoft Office (Word, Excel, PowerPoint)

ArcGis Pro

Experience in delivering real estate due-diligence services to lenders and owners that have included Property Condition Assessments (PCAs), Phase I Environmental Assessments (ESAs), Probable Maximum Loss (PML) evaluations, and Transaction Screening. During the last 8 years alone visited over 500 properties on a regional and national basis and helped provided concise and accurate written reports that have helped to strengthen the client's position with each transaction. experienced with a wide range of commercial property types including multi-family, retail, industrial, office, hotel and resort, and mobile home communities. Also experienced in many "wall street" and "main street" protocols including Fannie Mae, and Freddie Mac programs.

Project experience:

- Assisted in the development and execution over 500 PCA/ESA/PML or Combo Site Assessments using ASTM and client specific protocols on diverse properties to include major industrial facilities, shopping centers, office complexes, hotels, and other hospitality resorts, residential developments, mobile home parks, and nursing facilities throughout the continental United States, Hawaii, and Alaska. Consulting services provided included research of specific state and local regulatory requirements and advising clients as to the potential impact on proposed real estate developments, acquisitions, and industrial operations.
- Assisted in non-ASTM PCA tasks performed as part of the PCA/Construction Monitoring or Seller evaluation assessments included documentation reviews, estimating, municipality reviews and ADA analysis.
- Assisted in non-ASTM Phase I tasks performed as part of the Phase I assessments included asbestos inspection, sampling and analysis, radon testing, and lead-based paint assessment.
- Assisted in the development and implementation of Standard Procedures for preventative maintenance programs.

Contact Information:
801-440-0882
wainwright.nathan@gmail.com

NATHAN WAINWRIGHT

EDUCATION

Brigham Young University
Bachelor's of Civil and Environmental Engineering
Expected to graduate in December of 2018:

CAPSTONE PROJECT

Schaefer IndustriesSeptember 2017-Present
 Development and testing of an innovative design of structural steel tubing.

SKILLS & ABILITIES

- Experience in written and oral communication in a business setting
- Excellent abilities in Microsoft Office
- Experience in management and leadership positions

WORK EXPERIENCE

CMT Engineering Laboratories

Vineyard, UTOctober 2017-Present
 Perform a variety of tests on concrete and soil samples from construction sites and gather data to be used in Geotechnical reports.
 Occasional visits to client's construction sites.

Vivint:

Bismarck, NDApril 2015-August 2015
 Sales Representative (seasonal)
 Worked with clients to customize home-security systems.
 100% commission based, required initiative and hard work.

BYU Store

Provo, UTOctober 2014-October 2017

- Returns Coordinator: Contacted vendors about return policies and procedures and returned overstock, defective and damaged inventory accordingly.
- Textbook Expeditor: Main contact between the BYUStore and the textbook vendors. Communicate with vendors about pricing, orders, problems, etc.

REFERENCES

Tom Martin

- Former Employer
- 801-422-1455

Scott Taylor

- Mission President (LDS Mission)
- 801-633-7077