TXDOT PROJECT NO. 0-7193

DEVELOP ASSESSMENT AND MITIGATION GUIDANCE FOR ANCILLARY HIGHWAY STRUCTURES WITH EXISTING CRACKS

TASIG Annual Meeting

RESEARCH TEAM

UT Austin – Junghoon Sohn (PhD Student), Dr. Mojtaba Aliasghar, Dr. Aidan Bjelland, Dr. Todd Helwig, Dr. Matthew Hebdon, Dr. Salvatore Salamone

Texas A&M – HanGil Kim (PhD Student), Emily Bruening, Mike Nitsche, Dr. Arash Rockey, Dr. Stefan Hurlebaus, Dr. Peter Keating, Dr. Kinsey Skillen

AUGUST 28, 2024

Presentation Outline

- Introduction and Research Objectives
- Research Methodology
- Field Assessment
- Upcoming Lab Tests

Research Team (RT) – UT Austin

- Research Supervisors – Co-PIs: Todd Helwig, Matthew Hebdon, and Salvatore Salamone
- Research Assistants (GRAs and Post-Doctoral Researchers):
  - Junghoon Sohn (PhD Candidate)
  - Post-Doctoral Researchers: Aidan Bjelland, Mojtaba Aliasghar, Xiaoyi Chen (now at TxDOT)

Research Team (RT) – Texas A&M

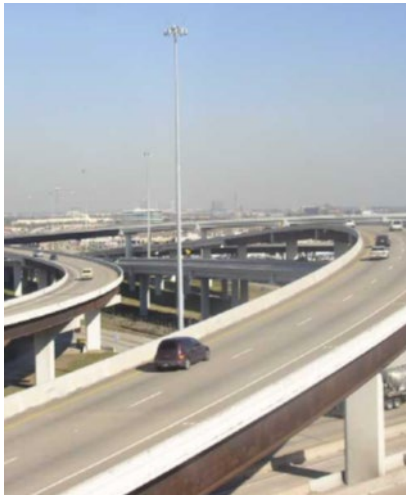
- Research Supervisors – Co-PIs: Stefan Hurlebaus, Peter Keating, and Kinsey Skillen
- Research Assistants
  - HanGil Kim (PhD Candidate)
  - Recently added: Emily Bruening, Mike Nitsche

Research Objectives

- This study is focused on the assessment and mitigation guidance of cracked ancillary structures

Traffic Signal Structure (TSS)

Cantilever Overhead Sign Structures (COSS)



High Mast Illumination Pole (HMIP)

Research Objectives

- The research will provide:
  - Assessments of the level of damage in various jurisdictions of Texas
  - Recommendations on TxDOT action – i) Monitoring, ii) Repairing, and/or iii) Potential Component Replacement
  - Assessment and Recommendations of Repair Techniques
  - Recommendations on certification methods/standards for inspection personnel

Research Background

- There have been a number of previous studies related to damage and fatigue performance of HMIP/COSS/TSS poles.
- The poles are all galvanized to improve the long-term corrosion performance.
- Galvanizing has been found to often initiate cracks in welds of components prior to the structural elements installation into the field. The likelihood of cracking is related to the geometry of the pole shaft and base plate.

Research Background

Field Monitoring (Magenes – 2011, Morovat et. al, 2018)

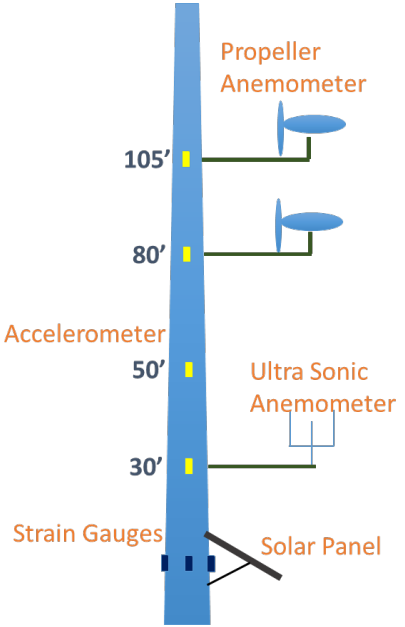
Research Background

Field Monitoring (Magenes – 2011, Morovat et. al, 2018)

In-service HMIPs instrumented and monitored for approximately one year.

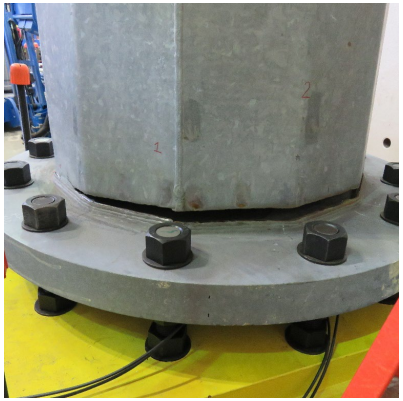
Locations:

- Austin (2011, 2018)
- Dallas (2018)
- Galveston (2018)
- Laredo
- El Paso (2011, 2018)



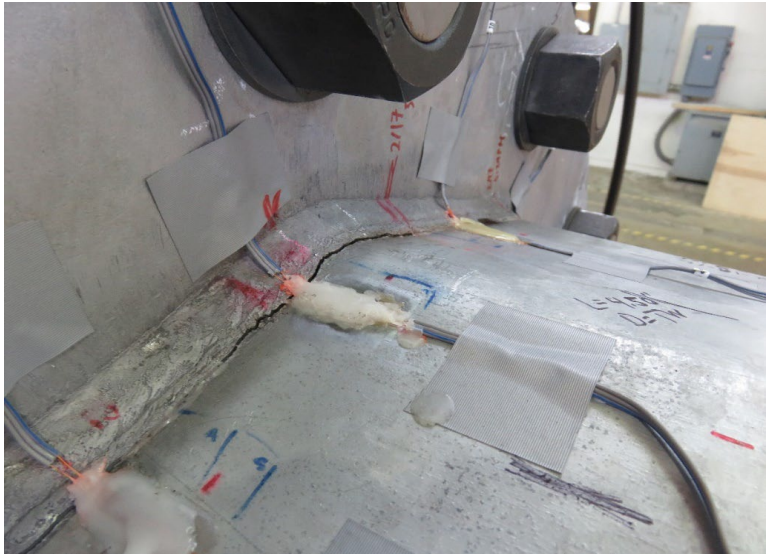
Research Background

Laboratory Testing (Pool – 2010, Balivanis – 2013, Morovat et. al, 2018)

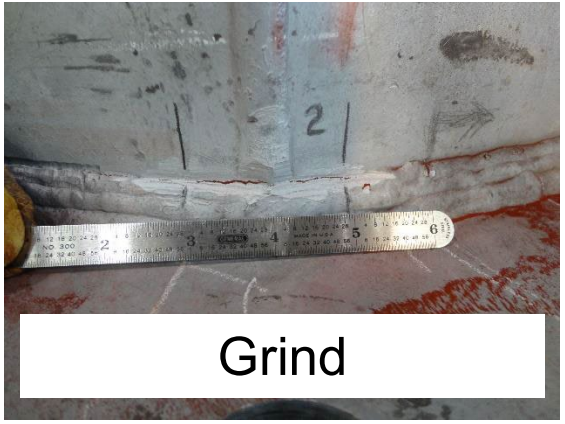


Research Background

Cracks are not generally visible by eye in the field, until very significant damage



Research Background (Repair Process)



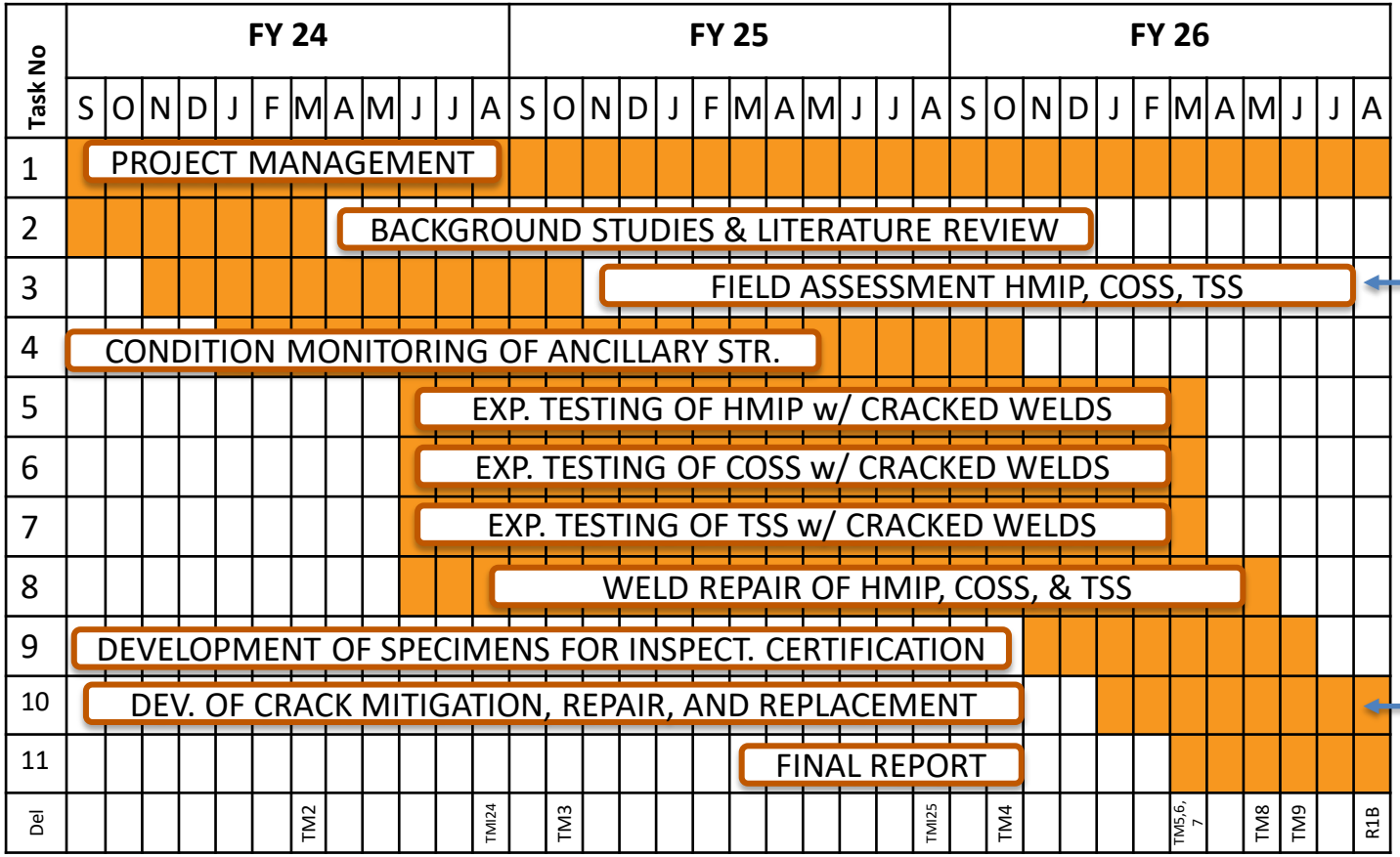
Research Background (Repair Process)

Weld Repair

Research Background (Repair Process)

Ultrasonic Impact Treatment (UIT)
Is this needed?

Project Overview by Task



Field Assessment

Experiments

Crack Mitigation and Repair

Research Objectives

- Detect and repair fatigue cracks in weld connection between pole and baseplate

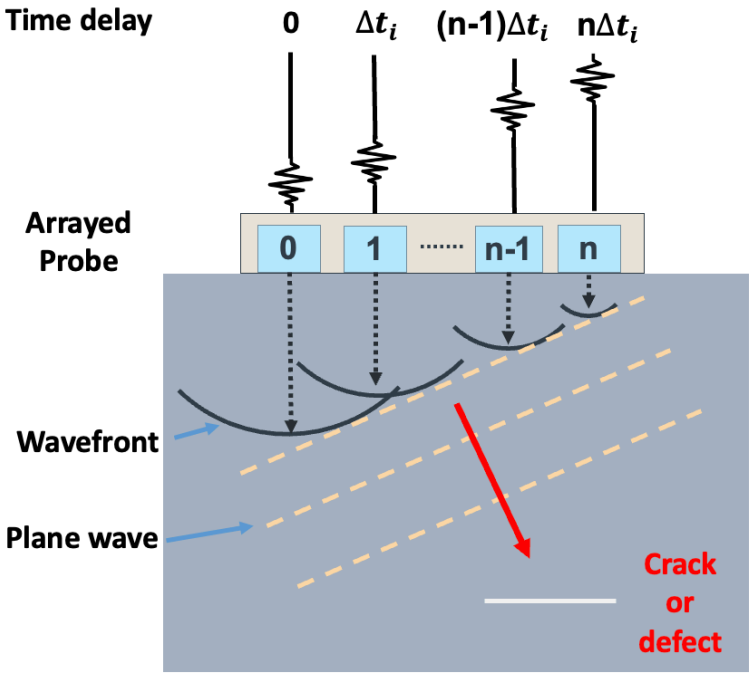
Detect Crack

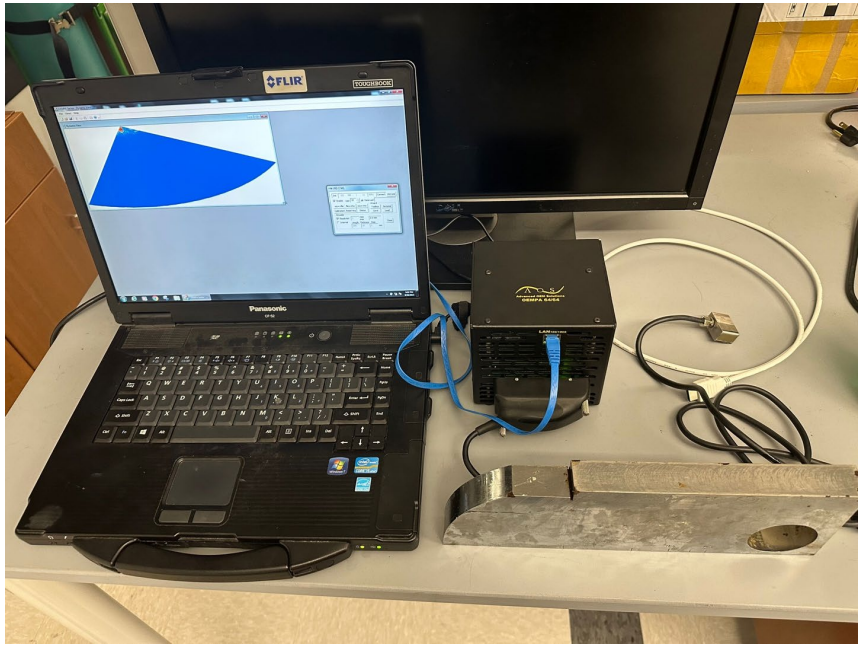
Repair Crack

Field Assessment of COSS, HMIP, and TSS Structures

Methodology

- Phased Array Ultrasonic Testing (PAUT)



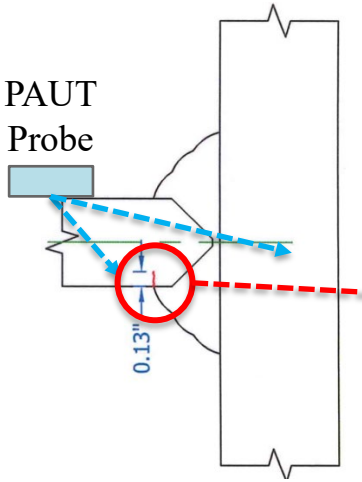


PAUT system

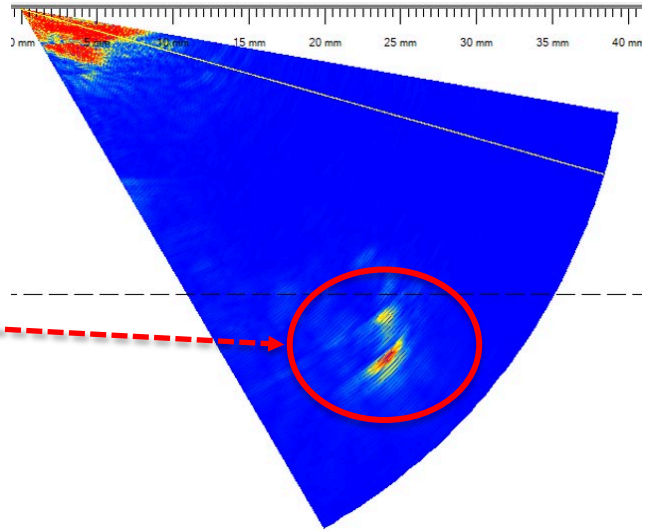
Methodology

- Validation using FlawTech Kit

FlawTech Specimen



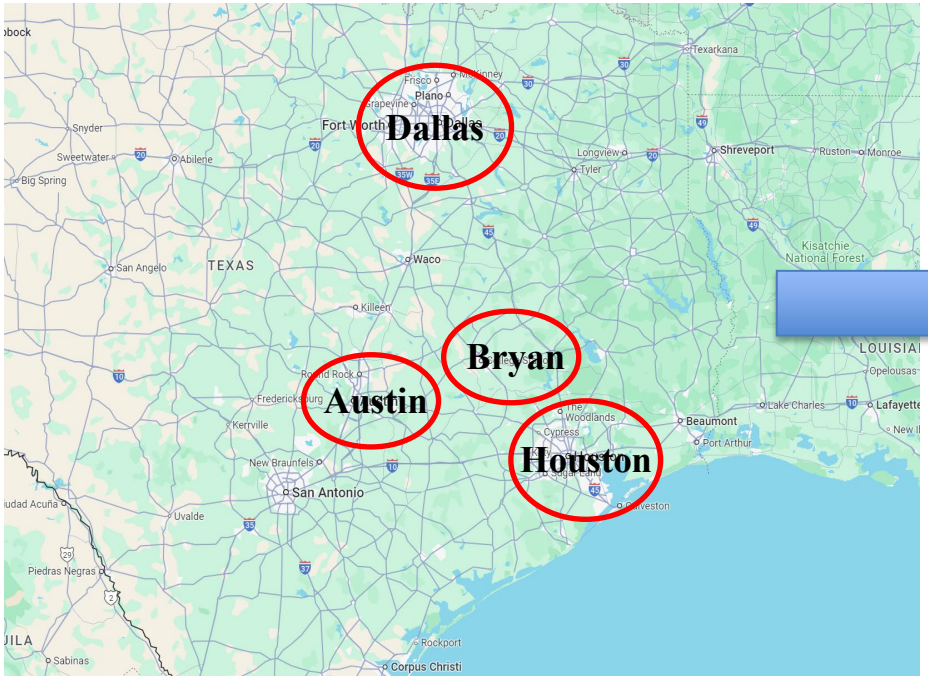
PAUT Process Schematic



PAUT Results

Field Assessment

- 10 TSS, 10 COSS, and 10 HMIP samples per region

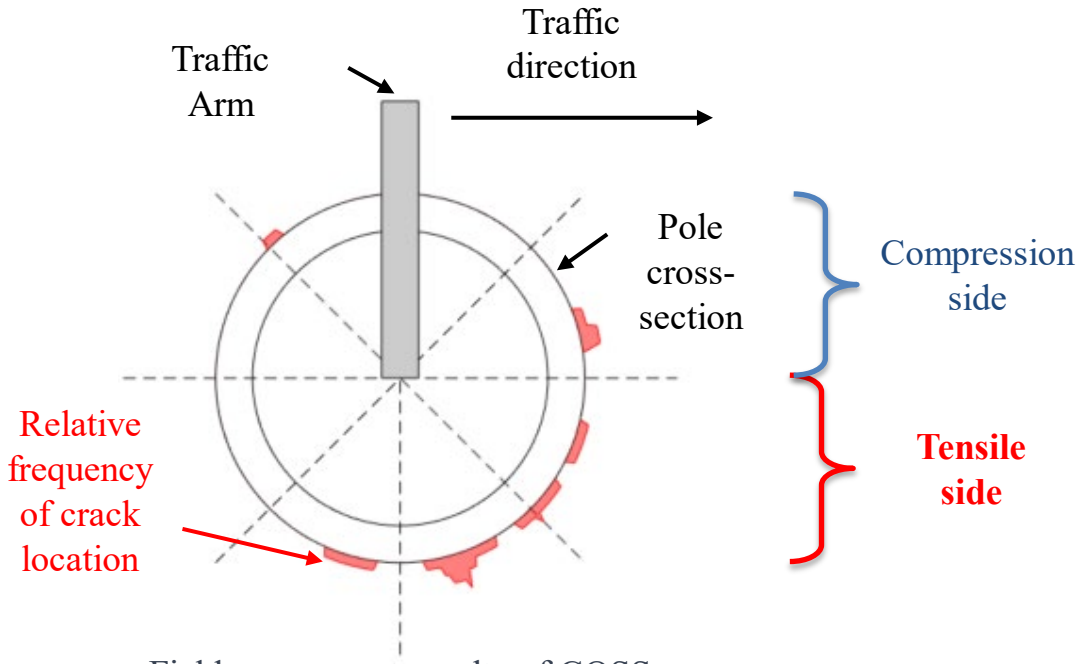


Total 120 Poles (HMIP, COSS, TSS)

- Geometry
- PAUT results

Field Assessment Results - COSS

- Crack locations and their frequency on COSS

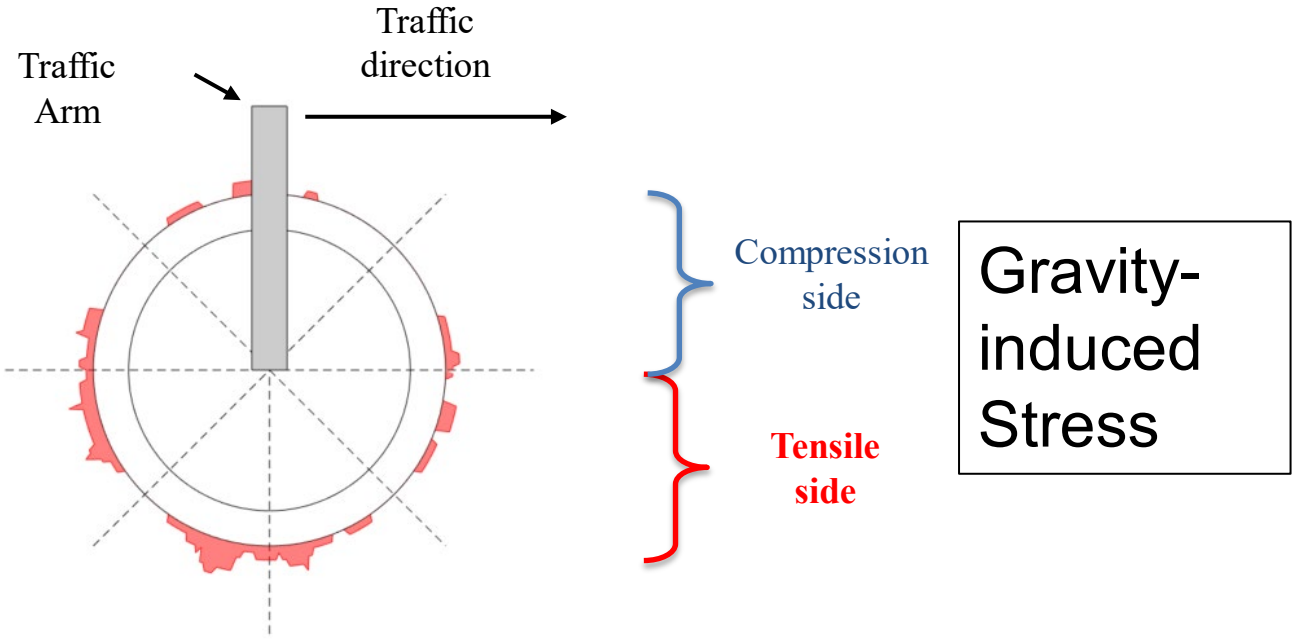


Field assessment results of COSS

Gravity-induced Stress

Field Assessment Results - TSS

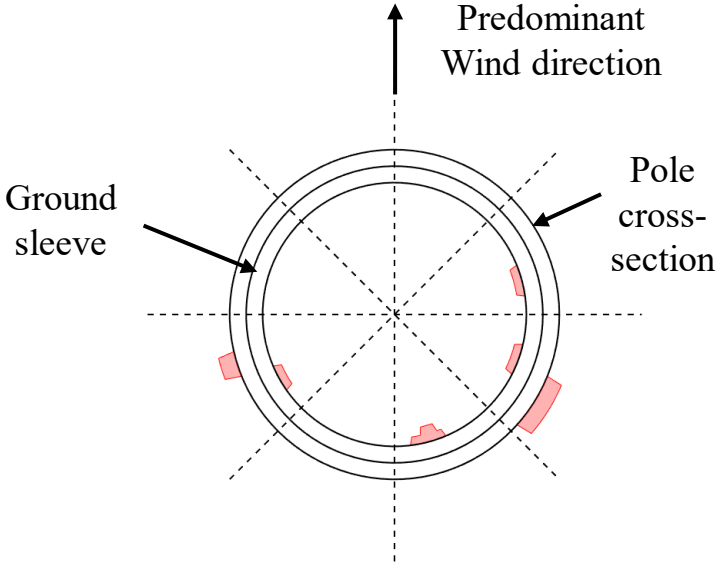
- Crack locations and their frequency on TSS



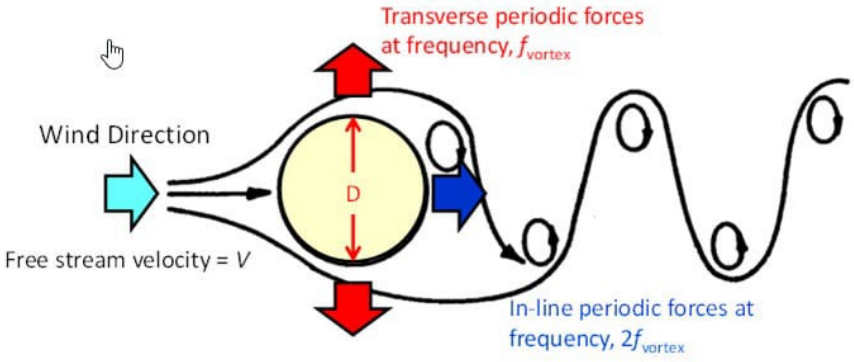
Field assessment results of TSS

Field Assessment Results - HMIP

- Crack locations and their frequency on HMIP



Field assessment results of HMIP



Vortex effect

Field Assessment Findings

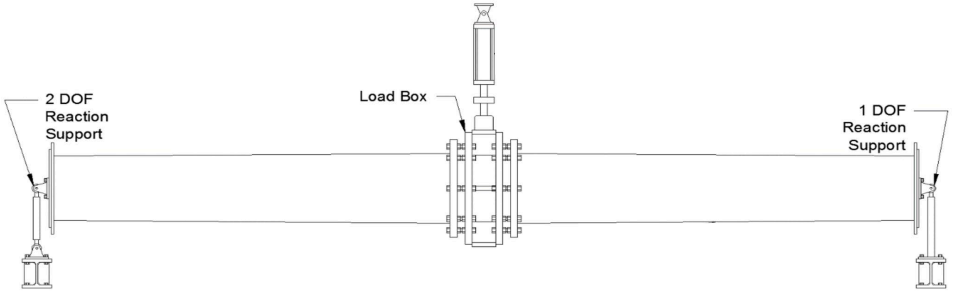
- For COSS and TSS, fatigue cracks typically initiate on the tensile side due to the self-weight of the traffic arm.
- For HMIP, fatigue is primarily caused by wind vortices, with cracks commonly occurring perpendicular to the predominant wind direction in the region.
- Data is still being reviewed; however, the characteristics of the cracking are continuing to be reviewed.

Laboratory Experiments on HMIP, TSS, and COSS Structures

Upcoming Lab Tests

- Induce and/or extend fatigue cracks by applying cyclic loading to the specimens

Tests at both UT and A&M on HMIP, COSS, and TSS Specimens. Cyclic loading to obtain cracks, study weld repair techniques and performance.



HMIP Specimen

- HMIP specimens obtained from Houston area. One specimen identified by A&M during field assessment and three more found with assistance from TxDOT. All specimens have been received by researchers.

HMIP Specimens

- One with ground sleeve and three without ground sleeves

Houston Beltway 8

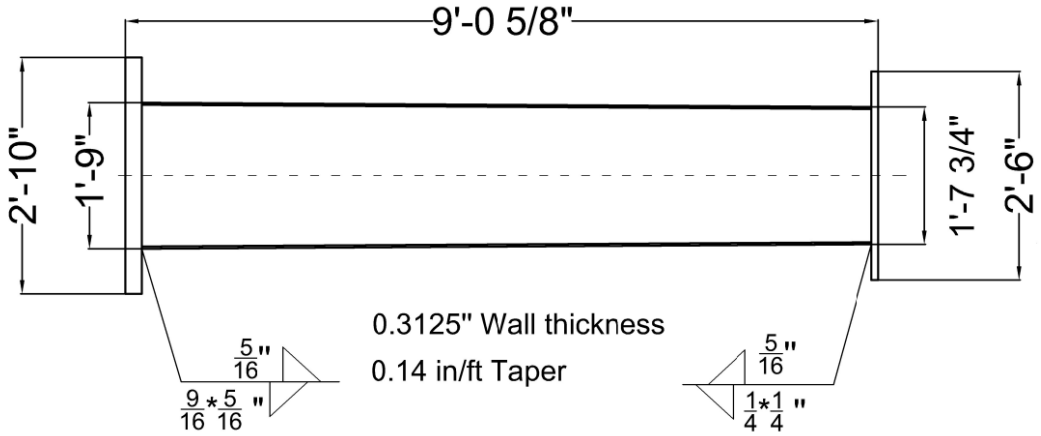
Dickenson on IH45

TSS Specimens from Field

- Texas A&M team members obtained a number of TSS specimens from the field. Two of the specimens have been identified as good candidates for testing on the present study.
- One specimen is multi-sided and one is round.
- Round Specimen has 17.75 in. square base plate 1.5 in. thick. Pole diameter is 12.5 in with wall thickness is 0.181 in.
- Multi-sided Specimen has 18 in. square base plate, 1.5 in. thick. Effective pole diameter is 11.75 in. with wall thickness of 0.25 in.

TSS Specimen – To Be Fabricated (Valmont)

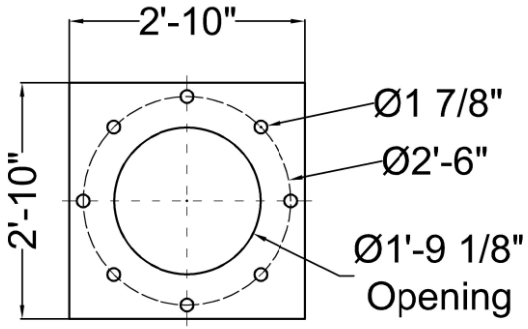
- Designed according to TxDOT standards, specifically following the Long Mast Arm Assembly, as it has been one of the most frequently issued concerns by TxDOT



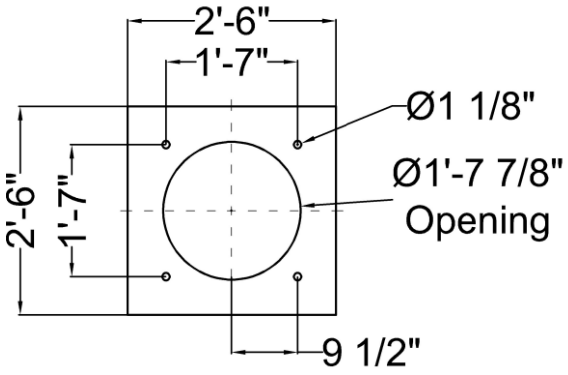
TSS Specimen

- Designed according to TxDOT standards, specifically following the Long Mast Arm Assembly, as it has been one of the most frequently issued concerns by TxDOT

Base plate 2.5" thickness

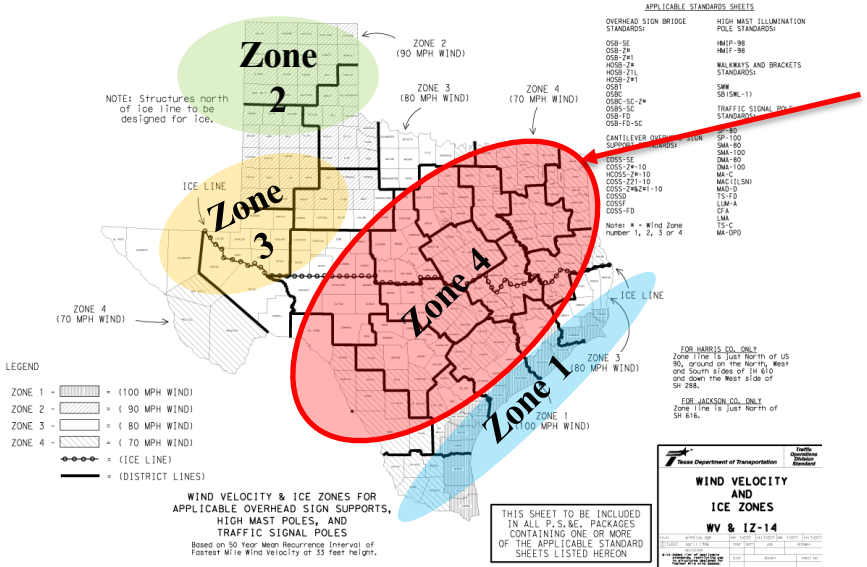


End plate 1" thickness

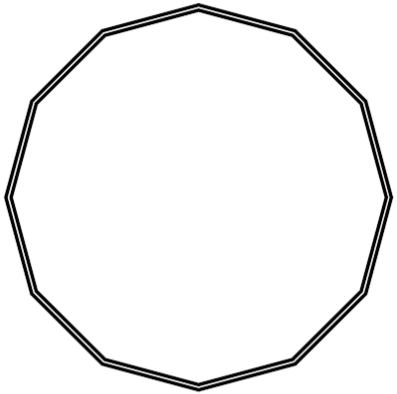


COSS Specimen – Likely to be Fabricated

- COSS is designed according to TxDOT standards, considering Wind Zone 4.
- It has a 24-inch diameter, larger than the 21-inch TSS but smaller than the 28-32 inch HMIP.



Austin
Bryan
Dallas



COSS (24 inches diameter)

Summary

- The field assessment of HMIP, COSS, and TSS Poles have been completed.
- HMIP and TSS Specimens have been obtained from the field for laboratory testing and repair studies. Additional COSS specimens from the field are desireable – but will be fabricated within the coming months if field specimens are unavailable.
- While the research team has become proficient in PAUT methods, additional information will be obtained during experiments since cracks can be “opened” from applied loading to improve understanding of resolution on readings.
- Experiments will be underway in the coming months at both UT and A&M.

Question Relating to HMIP Designs

With Ground Sleeve

Without Ground Sleeve

Question Relating to HMIP Designs

- Previous research showed that cracking during galvanizing could be greatly reduced or even eliminated by using a thicker shaft thickness.
- Should the practice of using a ground sleeve continue as the “preferred detail” for HMIPs
- Speaking with Carl Macheitto from Valmont at AASHTO, he commented on the significant expense of the ground sleeve during fabrication.
- Thoughts?

Thank-you!