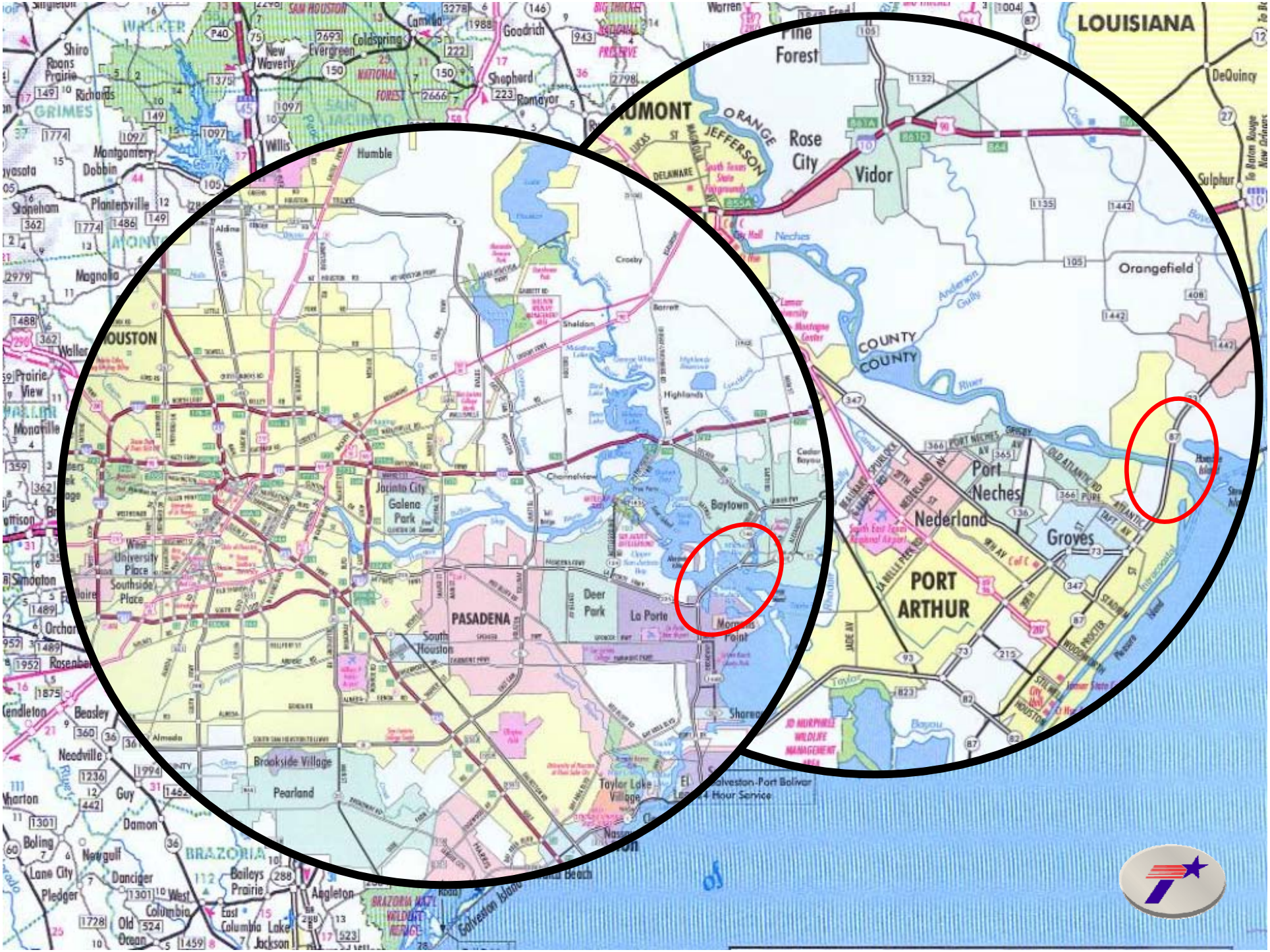
Texas Experience and Retrofits for Stay-Cable Vibrations

Keith Ramsey, P.E.
Director of Field Operations
Bridge Division – TxDOT

Texas Cable Stayed Bridges

- Fred Hartman – Baytown
- Veterans Memorial – Port Arthur

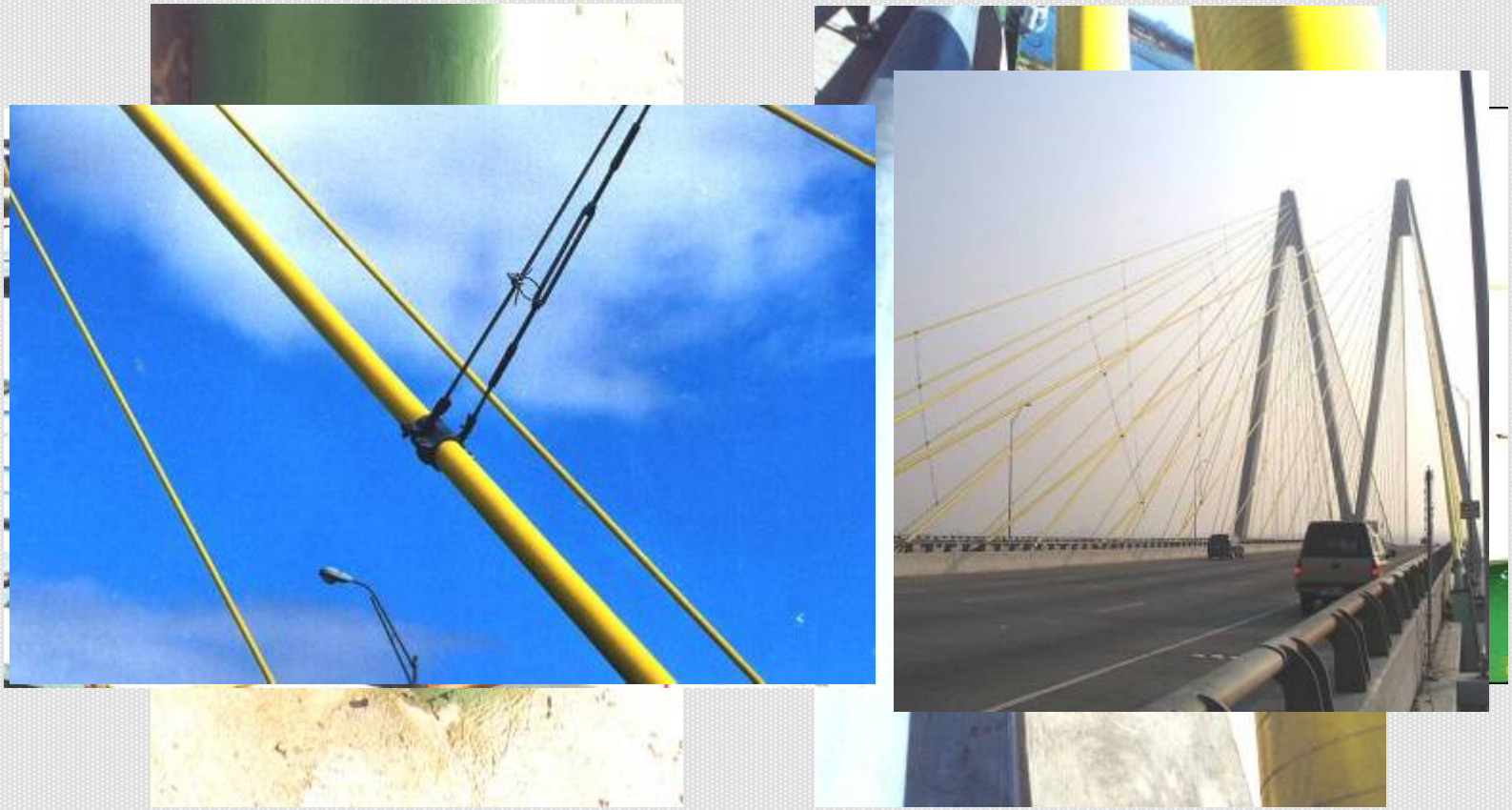

LOUISIANA
Fine Forest
Rose City
Vidor
Orangefield
Port Neches
Nederland
Groves
PORT ARTHUR
PASADENA
Deer Park
La Porte
Baytown
Jacinto City
Galena Park
Humble
Crosby
Highlands
Channelview
Pearland
Brookside Village
Taylor Lake Village
Galveston-Port Bolivar
Sulphur
DeQuincy
Orange
Jefferson
Delaware
Neches
Anderson Gulf
COUNTY
COUNTY
Taylor
Bayou
Magnolia
Montgomery
Plantersville
Willis
Coldspring
Shepherd
Goodrich
Camilla
Evergreen
New Waverly
Shiro
Roans Prairie
Richards
Stoneham
Dobbin
Waller
Prairie View
Monaville
Simonton
Orchard
Rosenberg
Kendleton
Beasley
Needville
Guy
Damon
Boling
Newgulf
Lane City
Pledger
Danciger
West Columbia
Old Ocean
Angleton
Baileys Prairie
East Columbia Lake
Jackson
Galveston Island
Almeda
Aldine
Sheldon
Barrett
Cedar Bayou
Port Neches
Taft
Atlantic
Old Atlantic Rd
Port Arthur
Nederland
Groves
Deer Park
La Porte
Baytown
Pasadena
South Houston
Jacinto City
Galena Park
West University Place
Southside Place
Houston
Humble
Crosby
Highlands
Channelview
Pearland
Brookside Village
Taylor Lake Village
Galveston-Port Bolivar
Sulphur
DeQuincy
Orangefield
Vidor
Rose City
Fine Forest
Orange
Jefferson
Delaware
Neches
Anderson Gulf
COUNTY
COUNTY
Taylor
Bayou
Magnolia
Montgomery
Plantersville
Willis
Coldspring
Shepherd
Goodrich
Camilla
Evergreen
New Waverly
Shiro
Roans Prairie
Richards
Stoneham
Dobbin
Waller
Prairie View
Monaville
Simonton
Orchard
Rosenberg
Kendleton
Beasley
Needville
Guy
Damon
Boling
Newgulf
Lane City
Pledger
Danciger
West Columbia
Old Ocean
Angleton
Baileys Prairie
East Columbia Lake
Jackson
Galveston Island
Almeda
Aldine
Sheldon
Barrett
Cedar Bayou
Port Neches
Taft
Atlantic
Old Atlantic Rd
Port Arthur
Nederland
Groves
Deer Park
La Porte
Baytown
Pasadena
South Houston
Jacinto City
Galena Park
West University Place
Southside Place
Houston
Humble
Crosby
Highlands
Channelview
Pearland
Brookside Village
Taylor Lake Village
Galveston-Port Bolivar

Texas Cable Stayed Bridges

- Fred Hartman vibrations

Fred Hartman Vibrations

- Immediate Retrofits



Texas Cable Stayed Bridges

- Veterans Memorial vibrations

Texas Stay Cable Vibrations

- Concerns
  - Serviceability of the stay system
  - Long term durability – Fatigue
  - How best to reduce vibrations
  - How to determine if damage occurred
  - Public Perception of Safety

Texas Stay Cable Vibrations

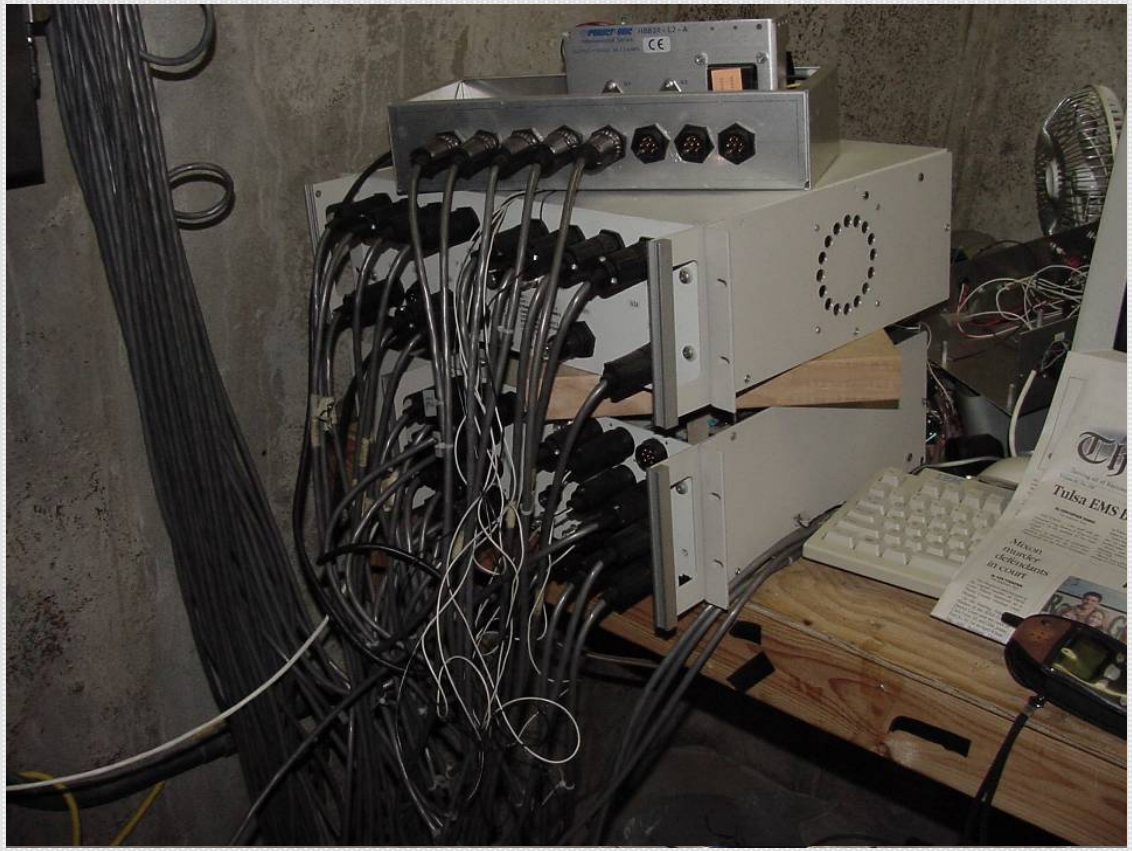
- Research Projects
  - Project 0-1400 – “Investigation of Wind/Rain Induced Stay Vibrations in Cable Stayed Bridges”
  - Project 0-1401 – “Determination of Fatigue Damage in Cable Stays”

Stay Cable Research Projects

- Project 0-1400 Methodology
  - Field Measurement of vibrations
  - Record meteorological data
  - Conduct wind tunnel tests
  - Develop mitigation strategies
  - Collect field data on mitigation strategies

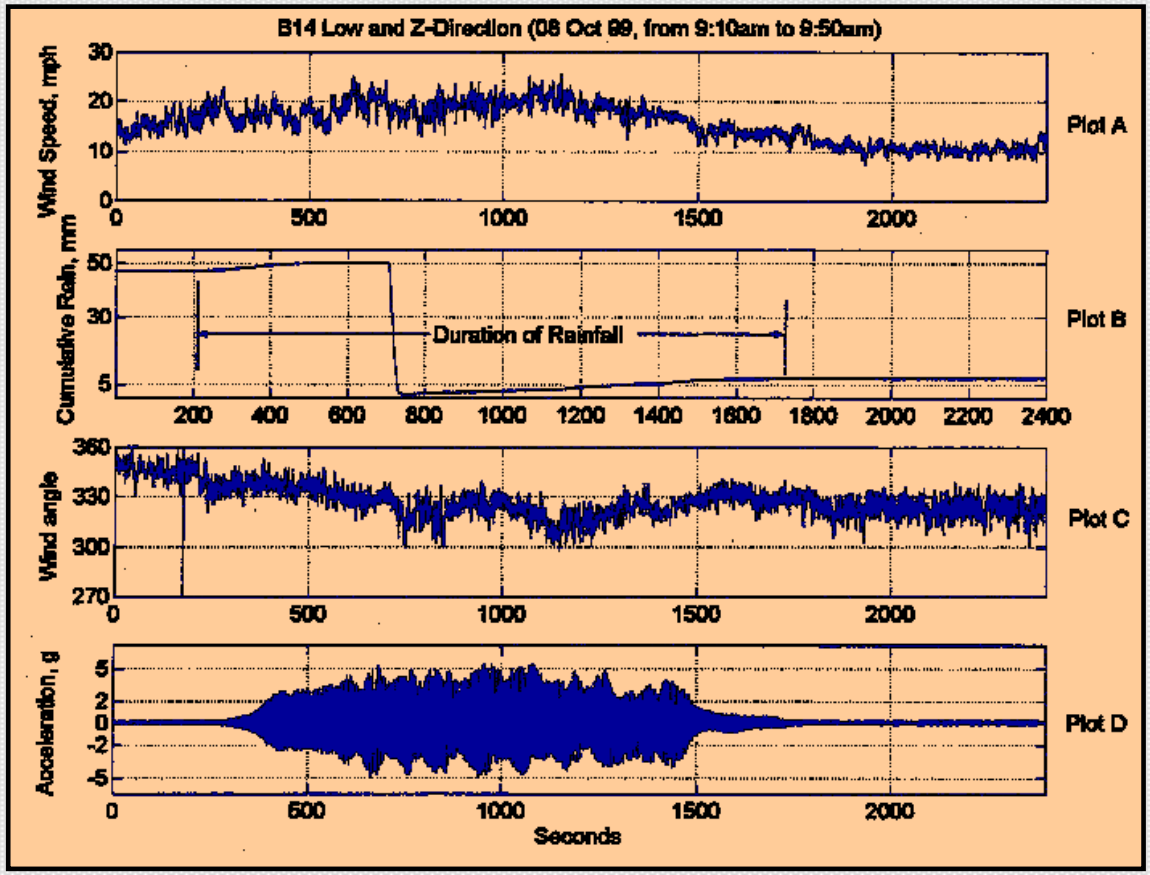
Project 0-1400 – Monitoring

- Monitoring instrumentation



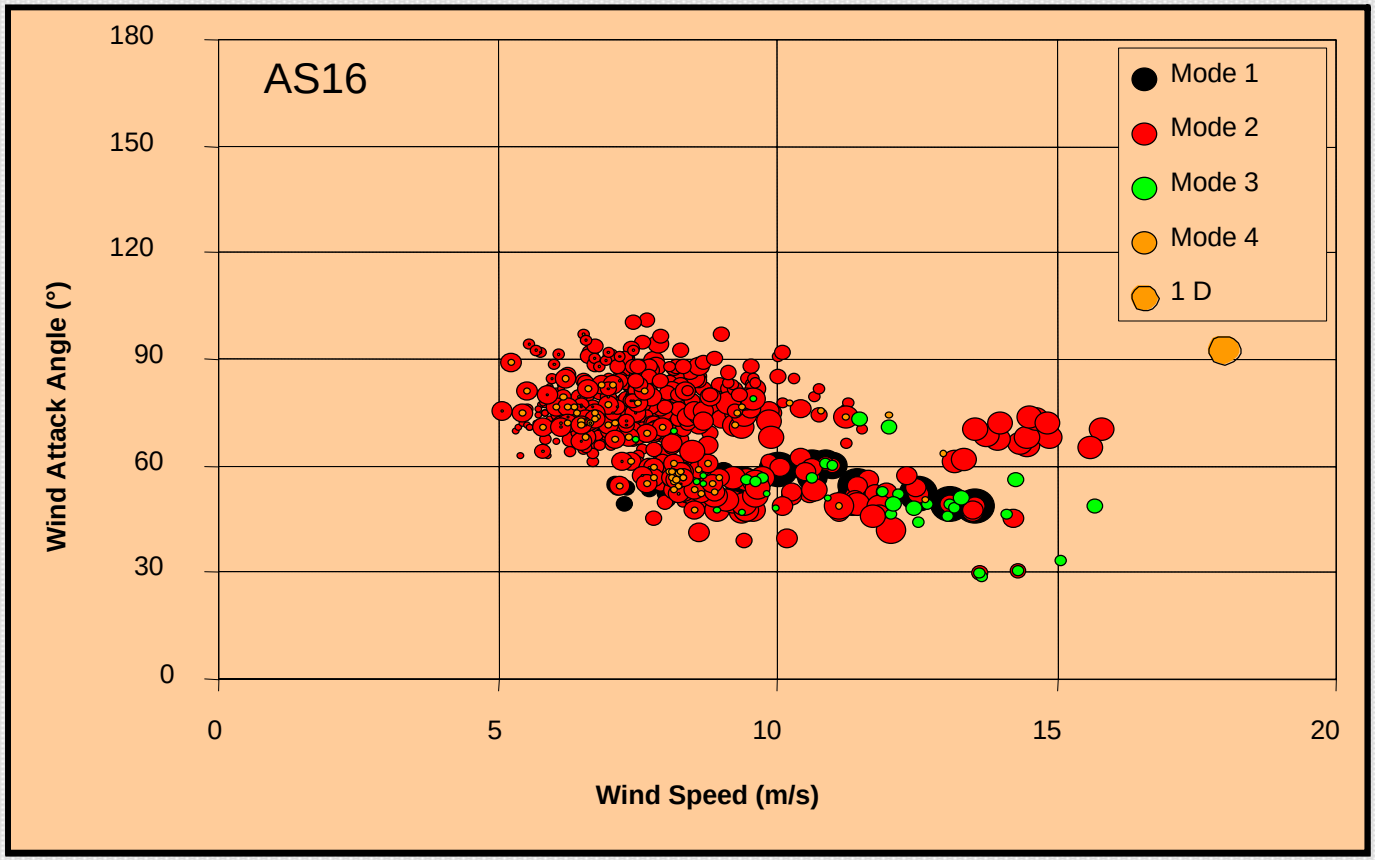
Project 0-1400 – Monitoring

- Wind/Rain vibration response



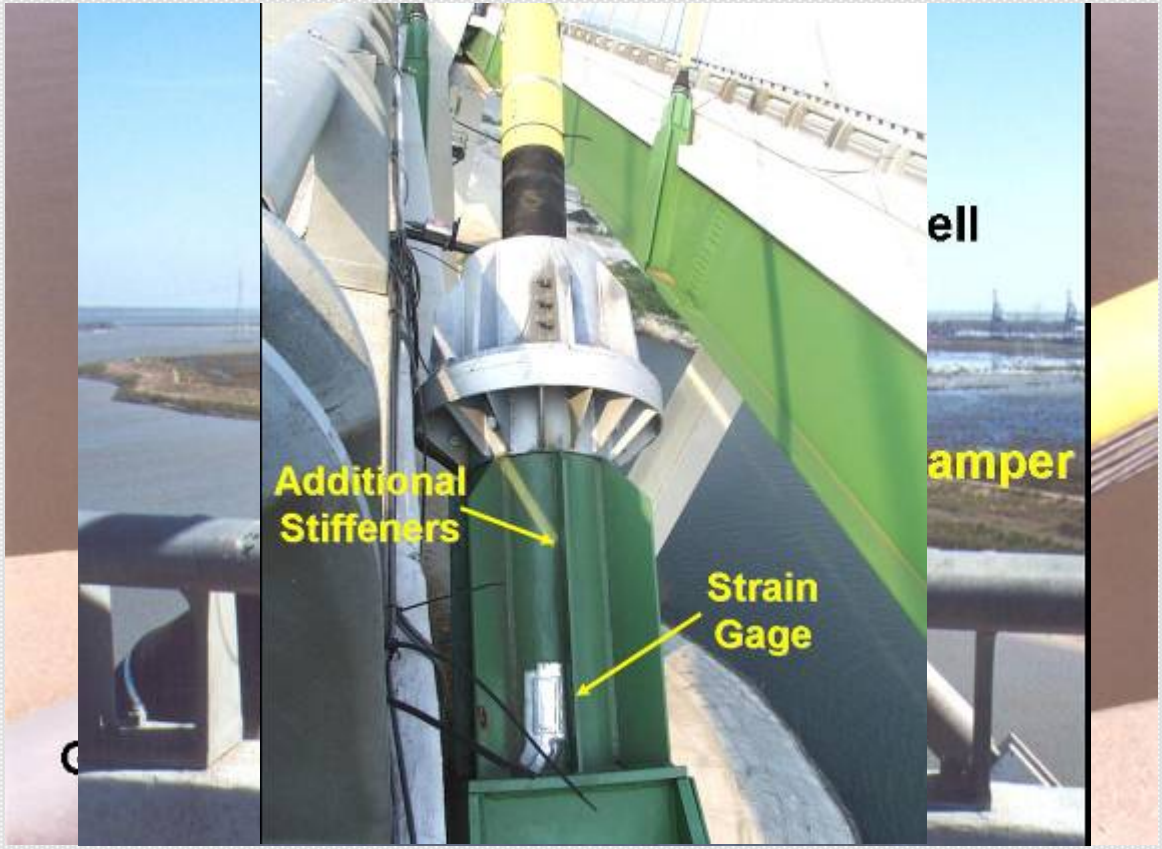
Project 0-1400 – Monitoring

- Dependence on wind direction



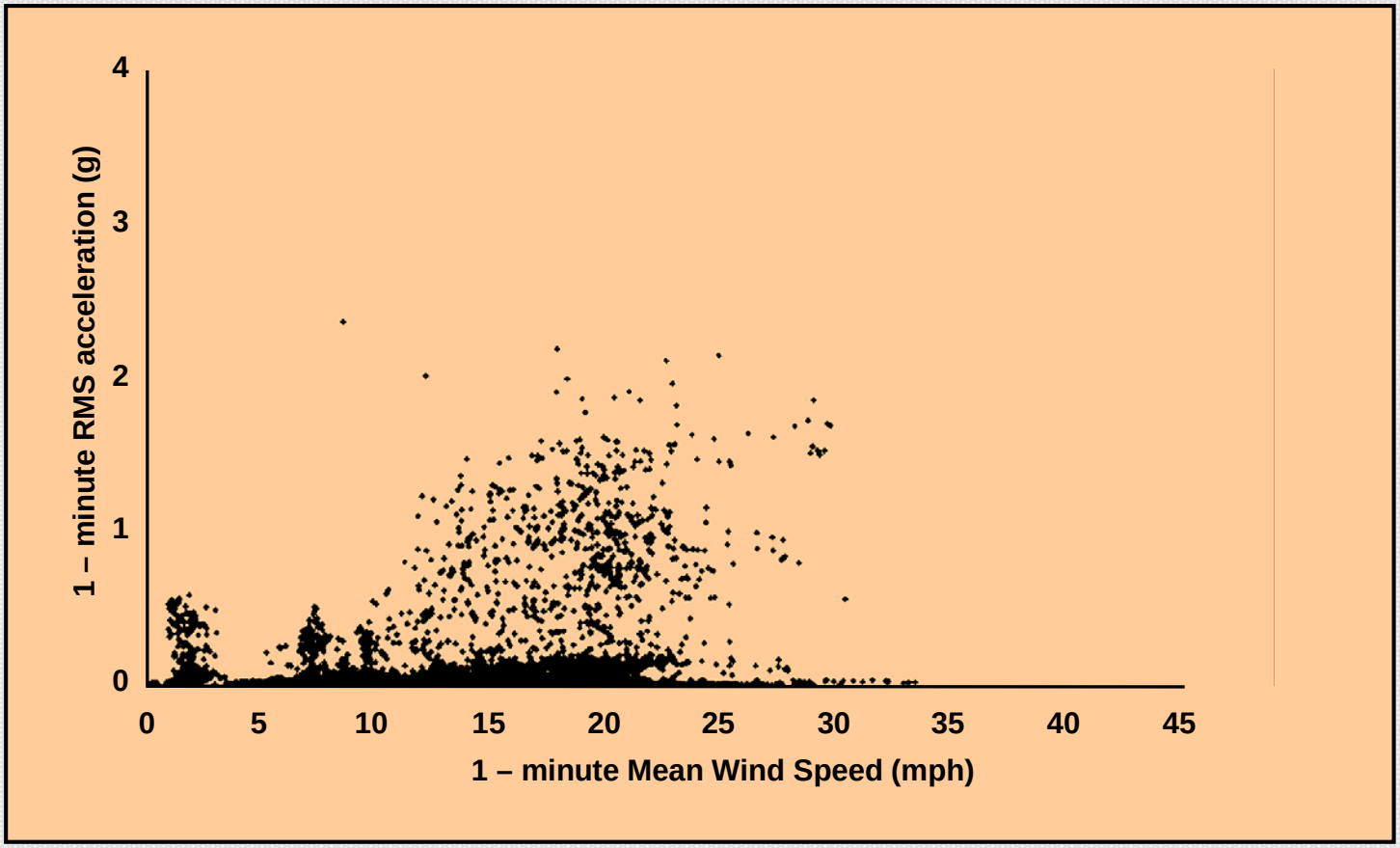
Project 0-1400 – Monitoring

- Prototype dampers



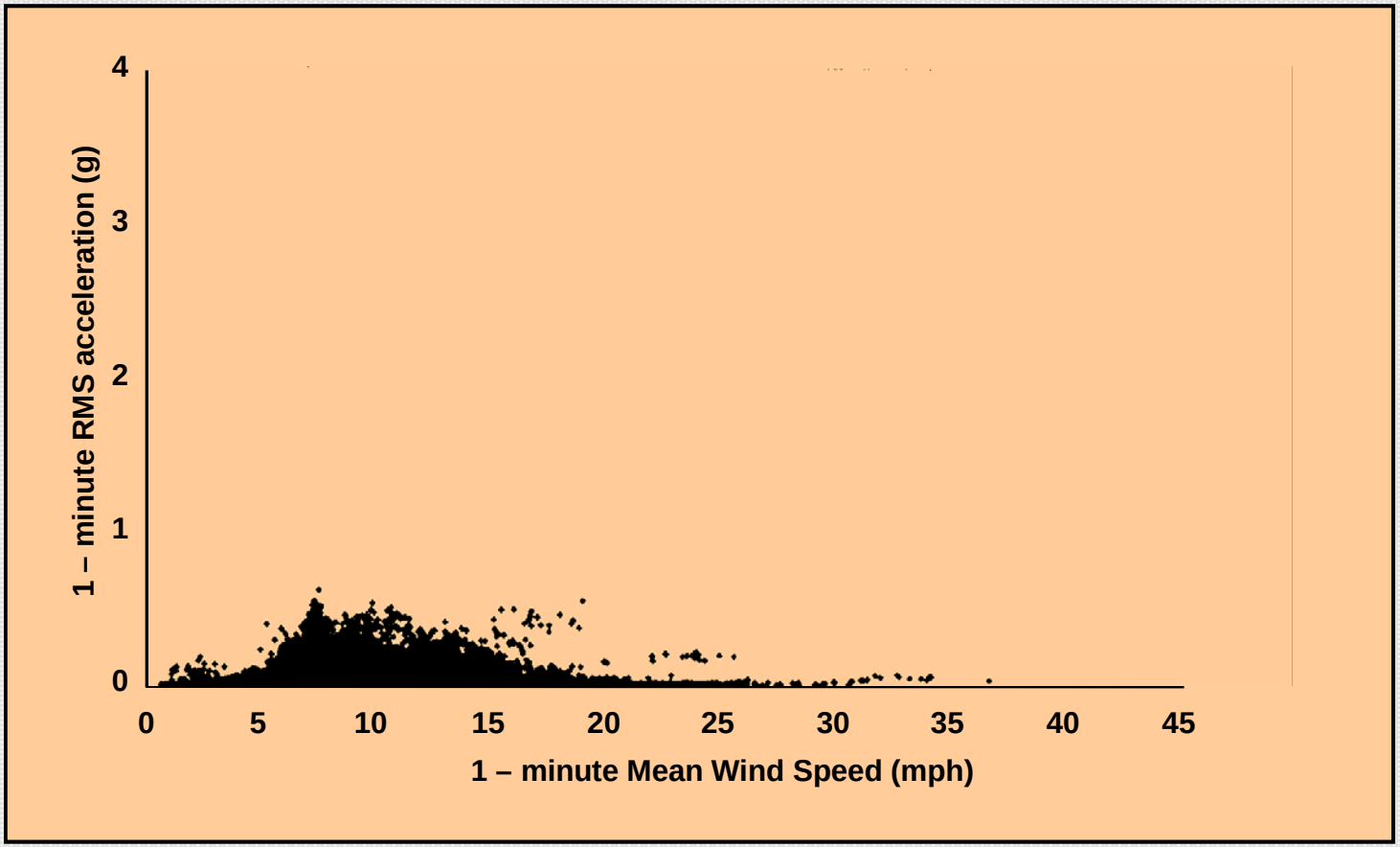
Project 0-1400 – Monitoring

- Undamped stay



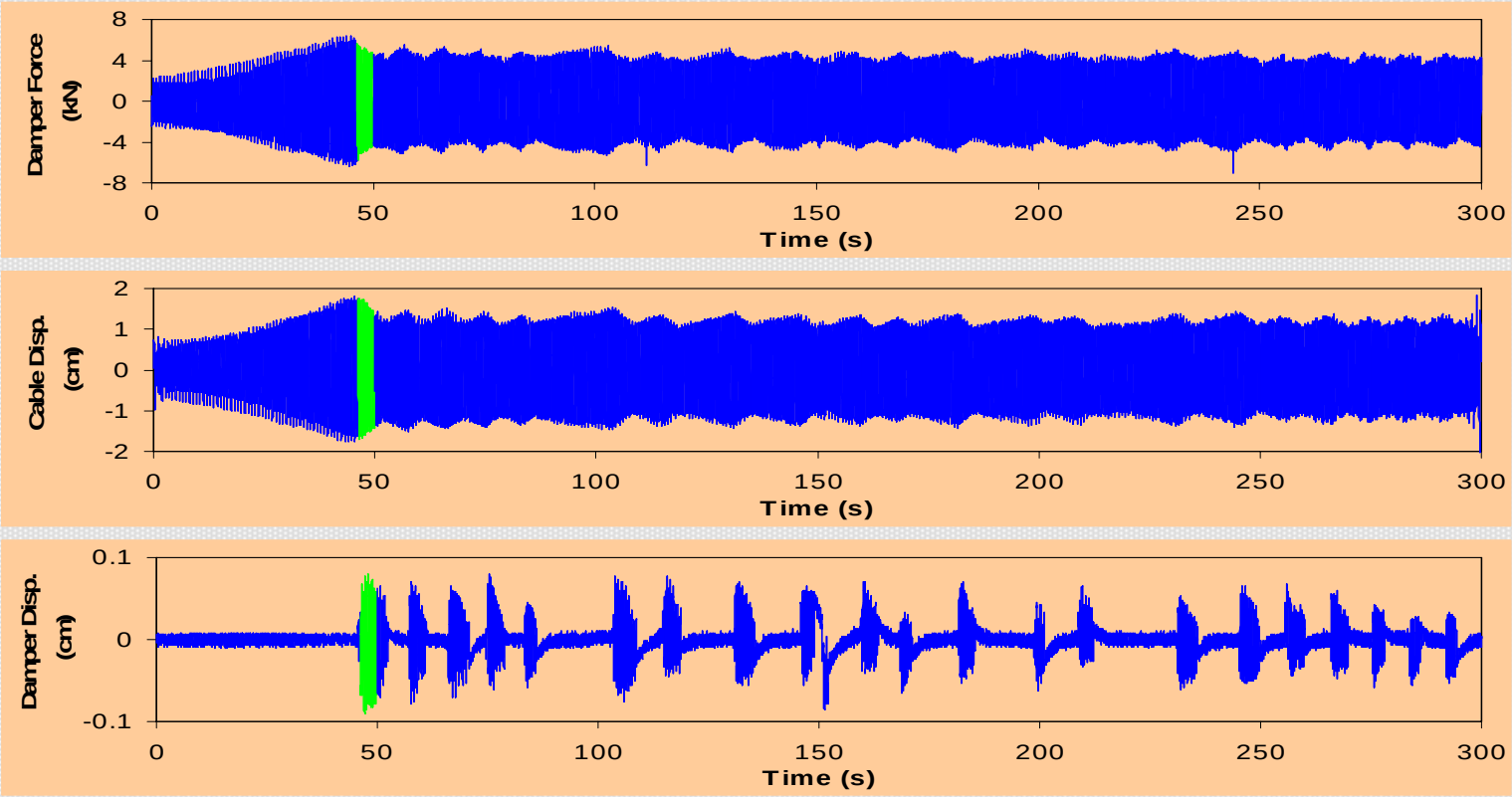
Project 0-1400 – Monitoring

- Damped stay – Viscous Damper



Project 0-1400 – Monitoring

- Viscous damper performance



Project 0-1400 – Monitoring

- Large amplitude vibration from:
  - Wind/Rain vibrations
  - Dry cable vibrations
  - Deck-induced vibrations
  - Vibrations yet to be categorized

Viscous Damper Installation

- Fred Hartman

Viscous Damper Installation

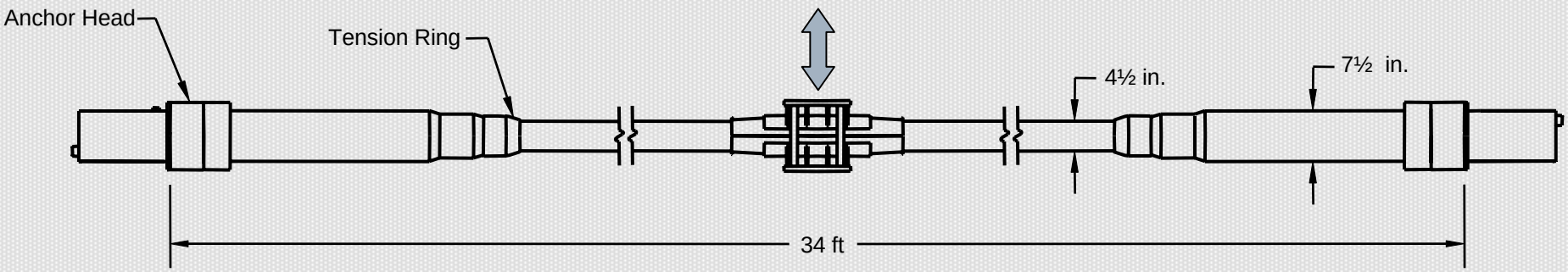
- Veterans Memorial

Cable Stay Research Projects

- Project 0-1401 Methodology
  - Measure field strain and acceleration response
  - Develop analytical models
  - Design and construct test specimens
  - Develop instrumentation plan
  - Conduct fatigue testing of specimens
  - Evaluate measured response
  - Correlate field and lab results
  - Predict remaining service life of stays

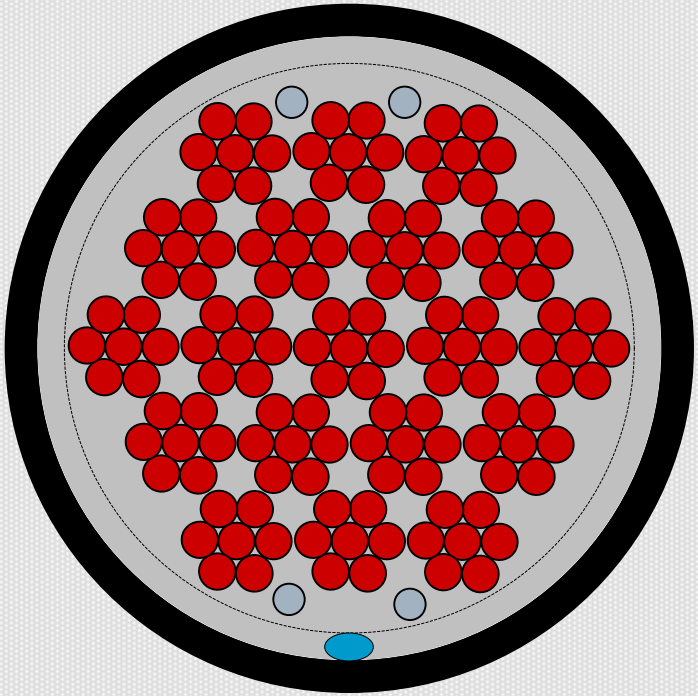
Project 0-1401 – Fatigue Testing

- Twelve large-scale specimens
  - Anchor heads – 19 strands
  - Overall length – 34 ft
  - Transverse loads applied at midspan



Project 0-1401 – Fatigue Testing

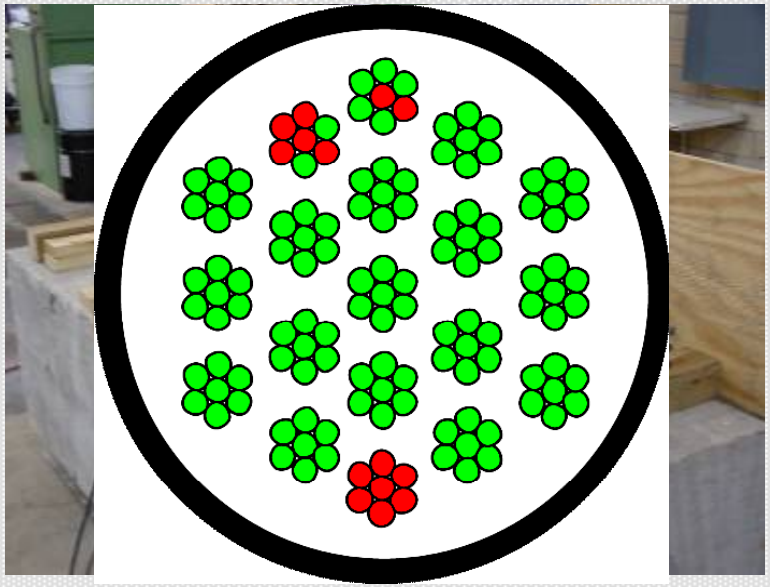
- 0.6”, 7-wire strand
- PE pipe
- Helical spacer wire
- Stress to 40% GUTS
- Grout

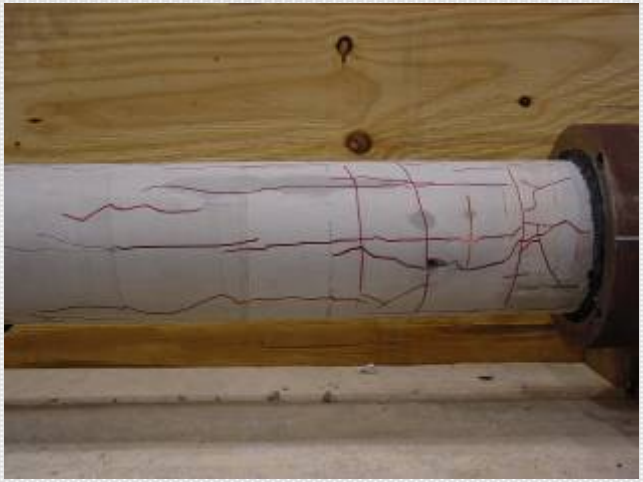


ALLIS-CHALMERS

Project 0-1401 – Fatigue Testing

- Specimen post mortem

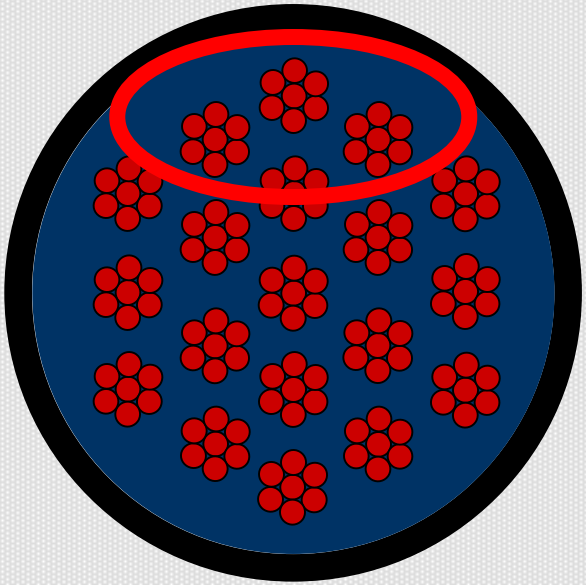


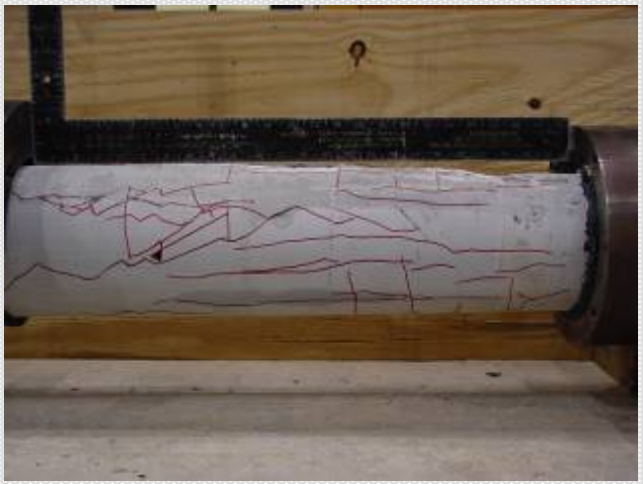


Project 0-1401 – Fatigue Testing

- Specimen post mortem

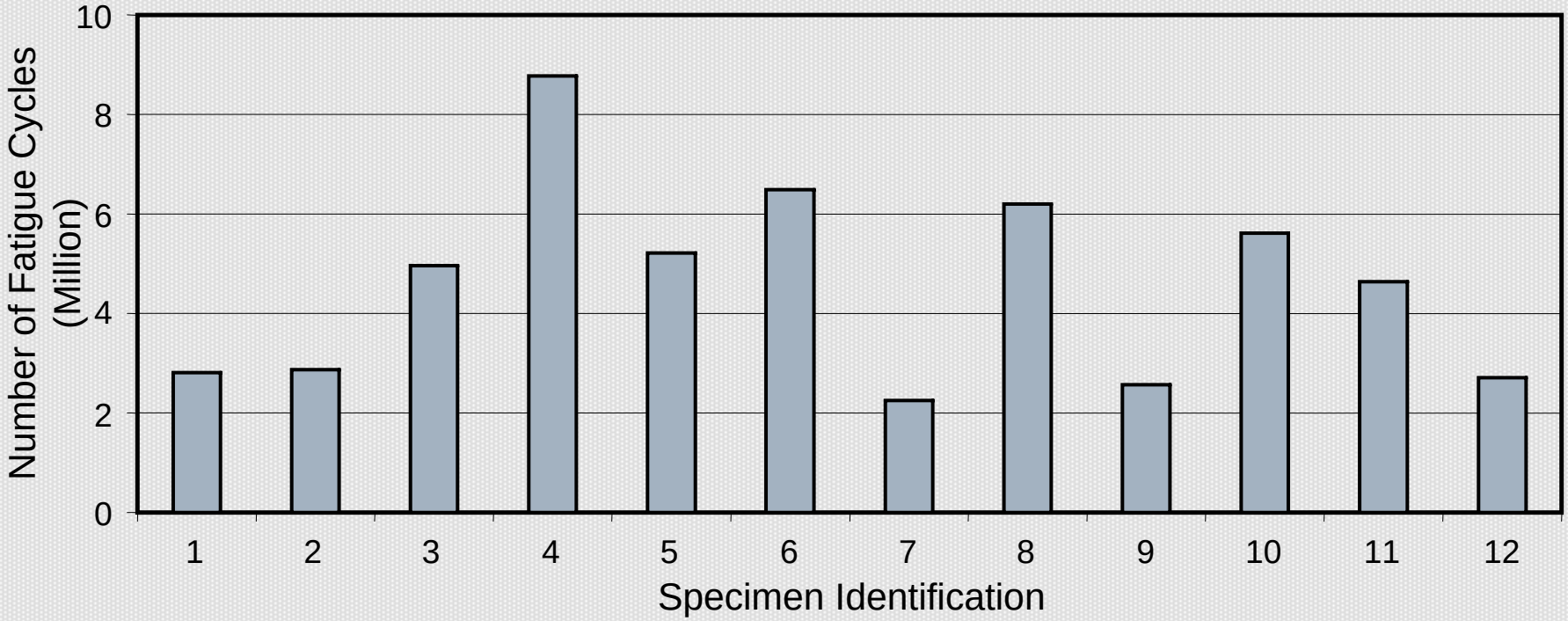
Grout Void





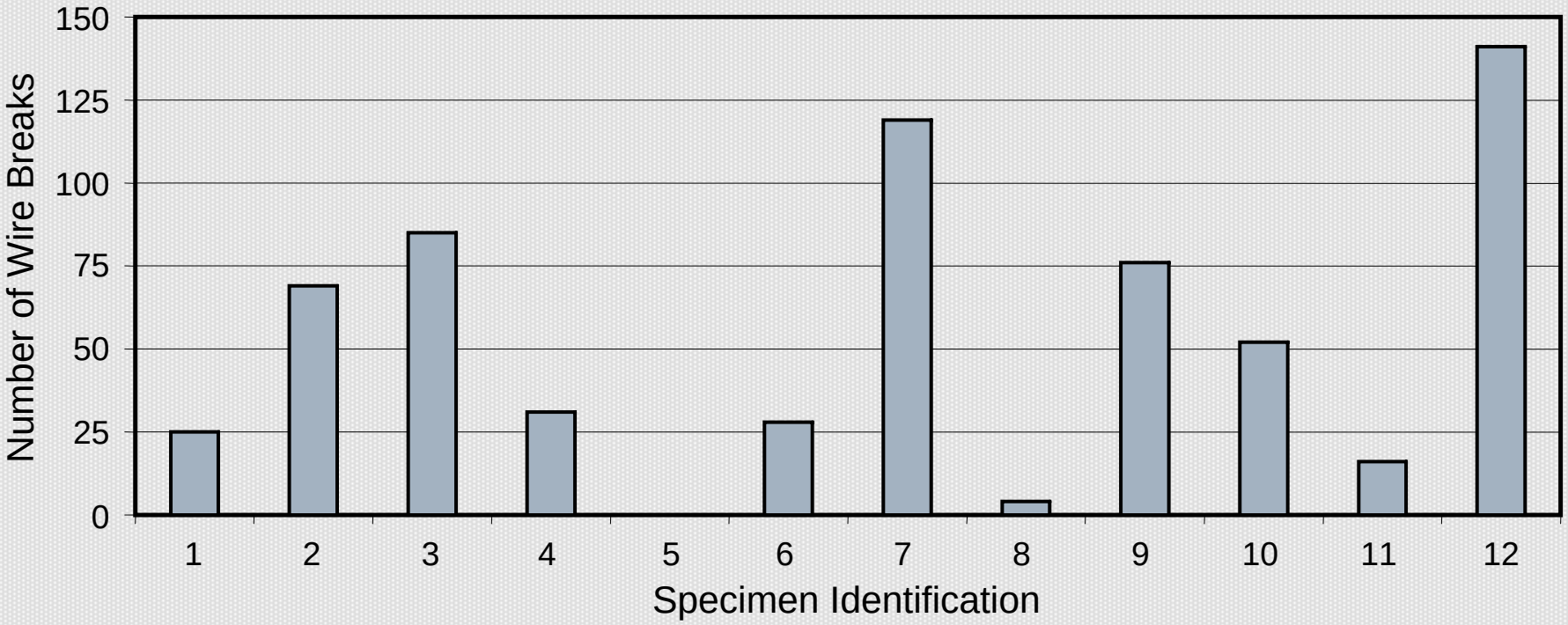
Project 0-1401 – Fatigue Testing

- More than 55 million loading cycles.
- More than 420 days of testing.



Project 0-1401 – Fatigue Testing

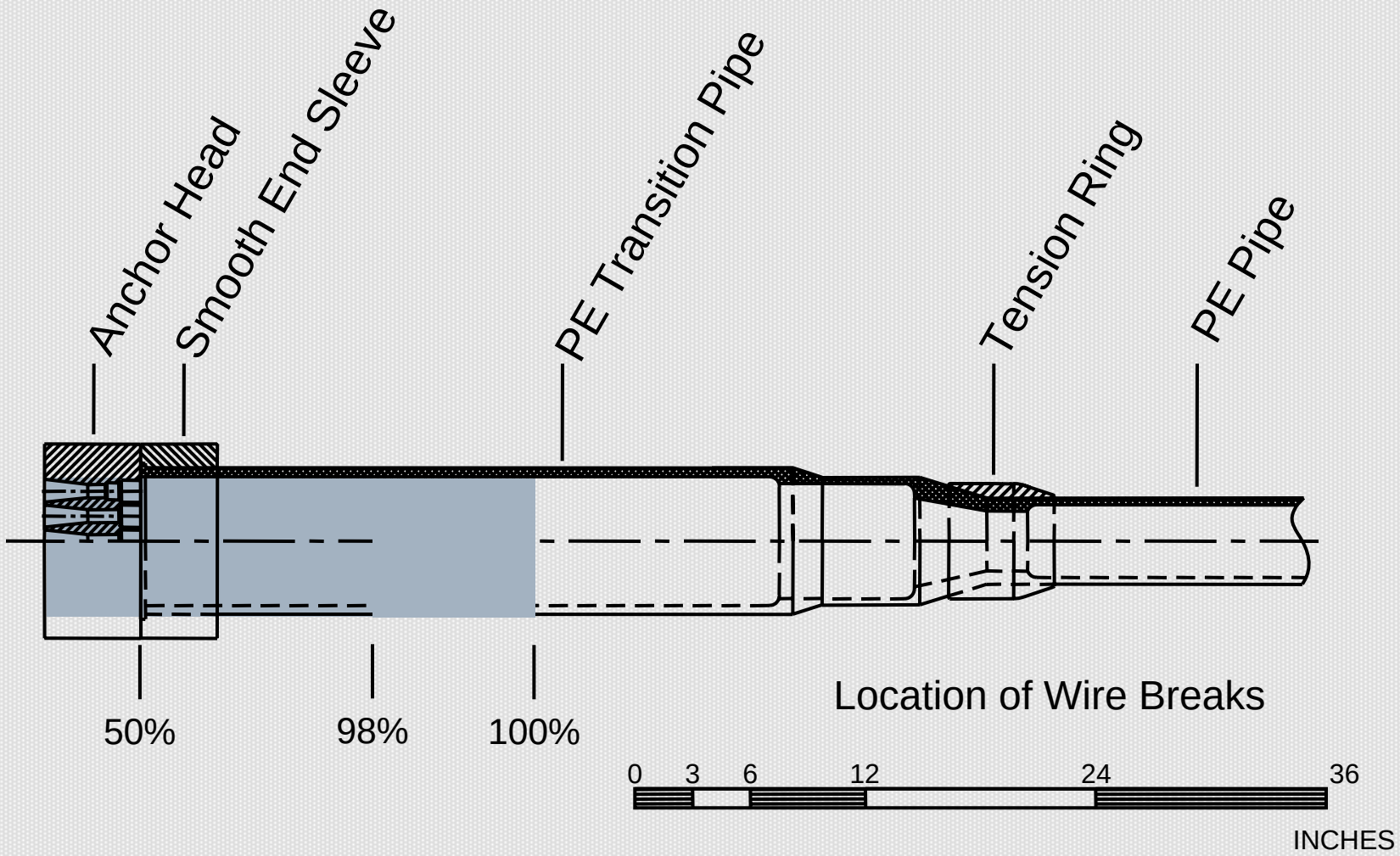
- More than 600 wire breaks.



Project 0-1401 – Fatigue Testing

- Wire break initiation points:
  - Fretting fatigue between wires in strand
  - Fatigue failure initiated by wedges
  - Fatigue failure initiated by corrosion pits
- Wire breaks are expected to occur at ends

Project 0-1401 – Fatigue Testing

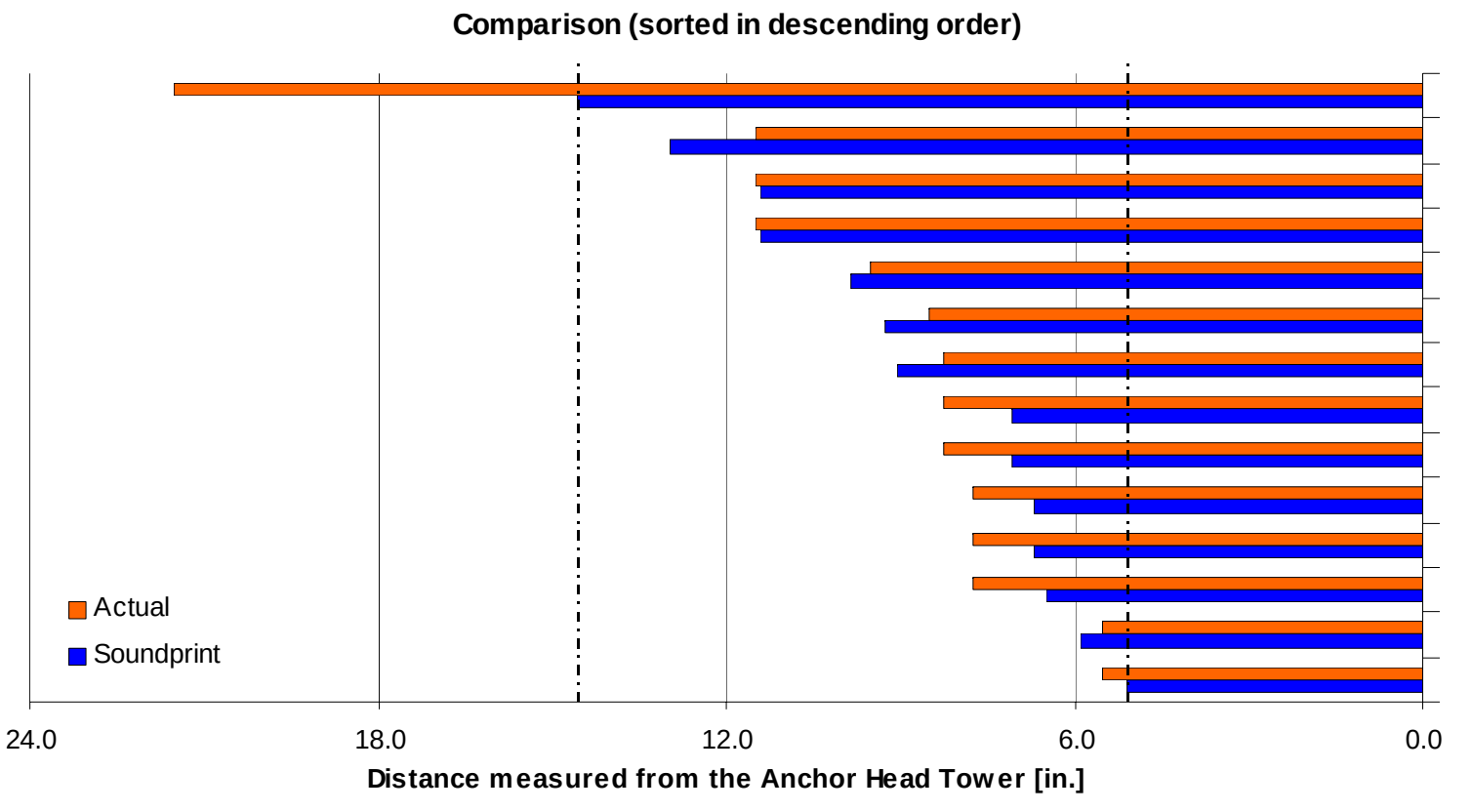


Project 0-1401 – Fatigue Testing

- Acoustic Monitoring Method
  - SoundPrint©
  - Used on all stay fatigue tests

Acoustic Monitoring

- Actual location vs predicted

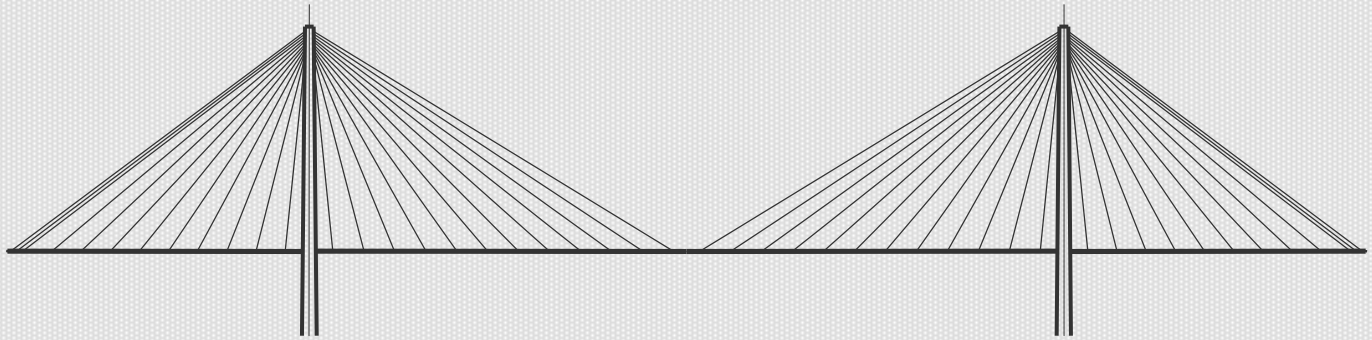


Fred Hartman Acoustic Monitoring

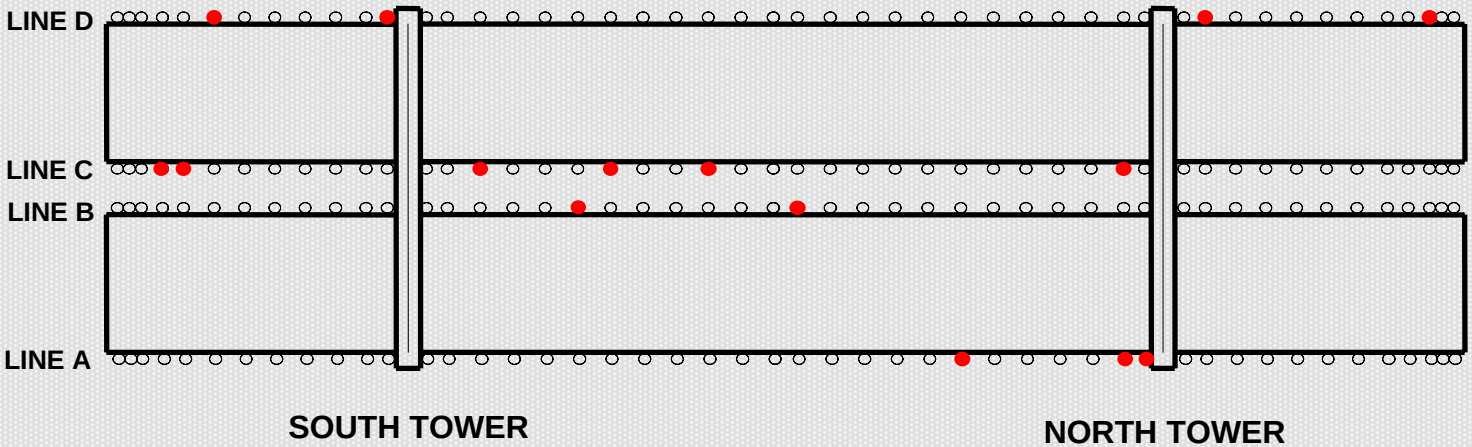
- Sensor locations

Fred Hartman Acoustic Monitoring

- Possible wire breaks



ELEVATION



PLAN VIEW

Questions?

Keith Ramsey, P.E.
Director of Field Operations
Bridge Division – TxDOT
kramsey@dot.state.tx.us
(512) 416-2250