Steel Poles & Sensitivity to Fatigue

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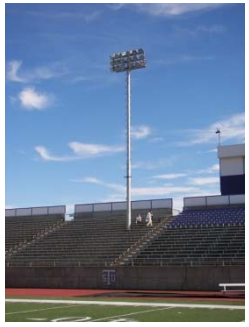
Reese
TOWER SERVICES

Steel Poles

- **Popular support structure in the communications, utility, traffic, and sports lighting industries for many decades**
- **Combine a long history of reliable performance, competitive pricing, and ease of use and installation**
- **The preferred support structure in many industries today**




Steel Poles & Fatigue

- **Fatigue is defined as the weakening or breakdown of material subjected to stress**
- **Fatigue does not always result in failure**
- **Fatigue can be very costly**

Steel Poles & Fatigue

Vibration → *Fatigue* → *No Failure*

or

Failure → *Fracture*

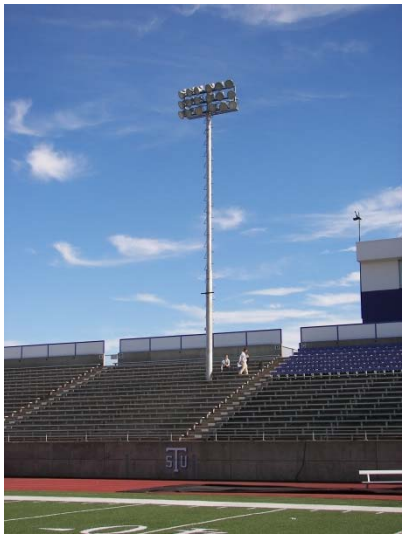
↓

High stresses *(thermal & mechanical)*
Defects *(weld procedures)*
Design errors *(undersized base plate)*
Excessive welding
Loose hardware

Steel Poles & Fatigue

- **How relevant is fatigue for steel pole structures today?**
- **What are other industries experiencing with respect to steel poles and fatigue?**
- **Is fatigue a design concern for steel structures and accessories?**

Sports Lighting



- **30 to 40 year old industry - “Friday night lights”**
- **Largely unregulated from a steel pole design standpoint**
- **Approximately 18 catastrophic failures of sports lighting pole structures across the country in recent years**
- **2010 Whitco Consumer Product Safety Commission recall**
- **Core issues:**
  - ✓ **No design standardization**
  - ✓ **No on-going maintenance**
- **Is fatigue an issue?**


photo source: www.HaysFreePress.com


photo source: www.HaysFreePress.com


photo source: www.Herald-Standard.com

Sports Lighting

- **No consistent structural design standard**
- **Historically no consideration of fatigue during design**
- **ASCE's *Athletic Field Lighting (AFL) Structures Standard Committee* formed in 2011 to address design standardization of steel poles used in sports lighting applications**
- **First draft of Standard underway; fatigue to be addressed**

Sports Lighting

AFL committee issued a press release on July 25, 2012, regarding structure design

- ✓ **Designers should use AASHTO 2009 edition**
- ✓ **Design for minimum 50 year life and Fatigue Category 1**
- ✓ **Recommend developing routine scheduled inspection and maintenance programs**

ASCE NEWS

American Society of Civil Engineers
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Reston, Virginia 20191-4400
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FOR IMMEDIATE RELEASE:
July 25, 2012

CONTACT: Jim Jennings
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Civil Engineers Creating Design Standard for Athletic Field Light Structures

Reston, VA--The collapse of more than twelve light structures at athletic fields around the country over the past several years, and another 200 other sports lighting structures removed from service as a safety precaution, has prompted members of the American Society of Civil Engineers (ASCE) to examine these structures and create a new design standard for the industry.

The ASCE Athletic Field Lighting Structures Standard Committee was created in the fall of 2011 and is working to create a national consensus standard for the proper specification, design and system support of these structures.

"In the United States, current practices related to the specification, fatigue design, installation and on-going maintenance of athletic field or other area lighting structures are very inconsistent," said Brian Reese, P.E. of ReliaPole Inspection Services Co., chairman of the committee. "When we started looking at these failures, we surmised that fatigue resulting from wind induced vibration as well as a lack of inspection and maintenance programs are believed to have played critical roles in these failures."

Reese noted that in the past, some design professionals have used the International Building Code as a design guide, but that code is not particularly adaptive to lighting support structures. He said other designs rely on the American Association of State Highway and Transportation Officials (AASHTO) *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*. Other designs rely on commercial grade specifications developed by the individual lighting system suppliers, Reese said.

Until the new committee comes up with a new, formal standard, the committee recommends the following interim measures:

1. Design professionals should use the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*, fifth edition with 2010 and 2011 interim revisions.

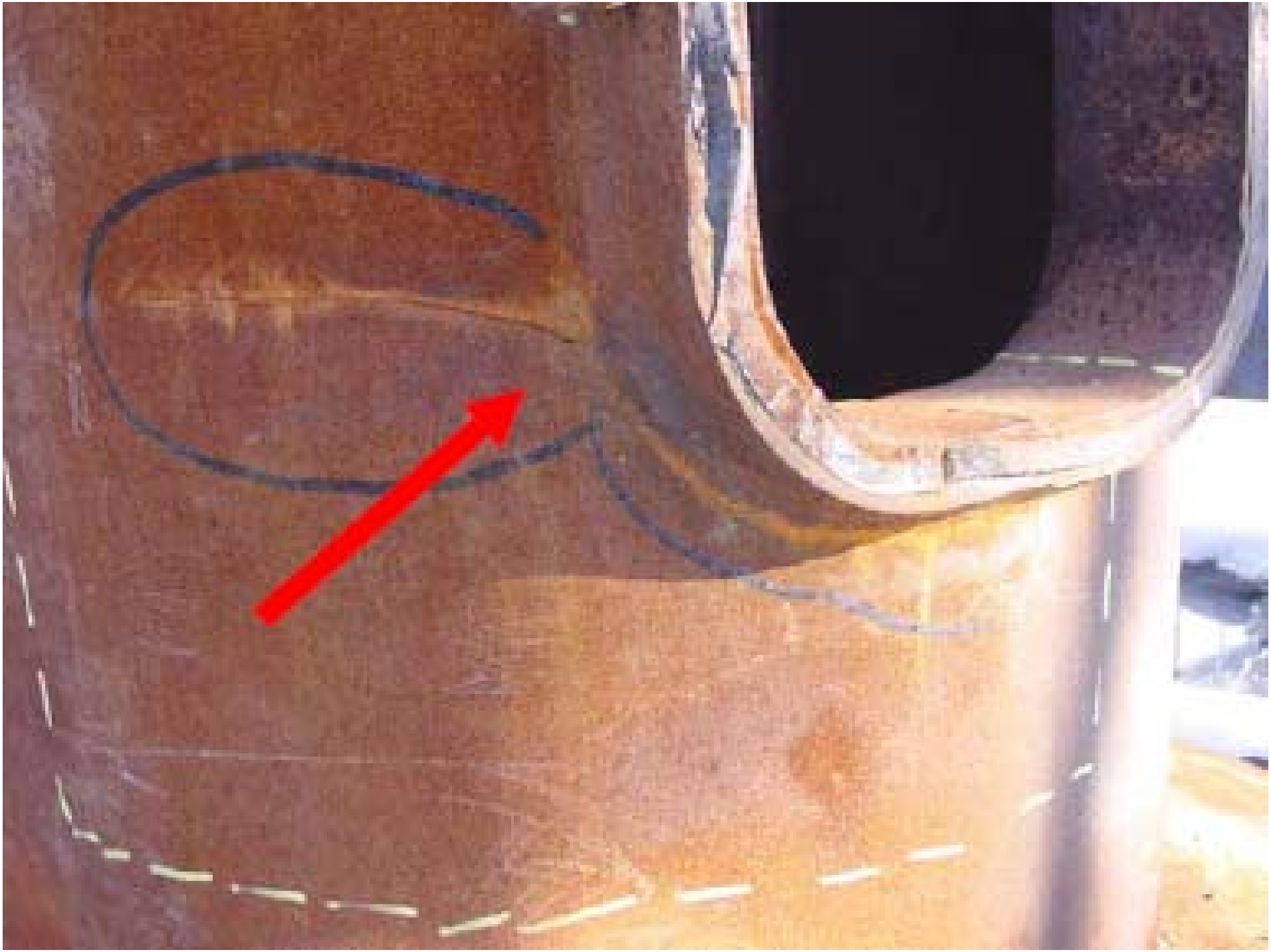
www.asce.org

ASCE

Traffic

- **Extensive use of steel poles and pole structures since the ‘50’s and ‘60’s and the growth of the interstate system**
- **High mast lighting, overhead sign support structures, lighting poles, mast arms, signal support structures, cantilevers**
- **Hundreds of thousands of structures**
- **Is fatigue an issue?**


HERNDON PKWY
09.09.2010



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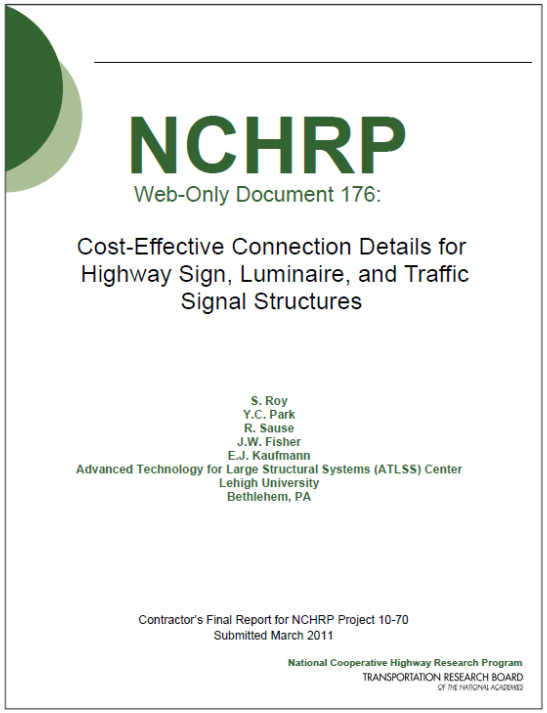
Traffic

- **Fatigue a recognized industry concern and design issue for the past decade**
- **Significant research on fatigue at university level and in conjunction with the National Cooperative Highway Research Program (NCHRP)**

Traffic

- **NCHRP Project 10-70; March 2011**
- **Traffic connection detail research project at Lehigh University**
- **78 full size galvanized specimens tested & FEA**
- **Emphasis on connection geometry on fatigue resistance**


NCHRP

Web-Only Document 176:

Cost-Effective Connection Details for Highway Sign, Luminaire, and Traffic Signal Structures

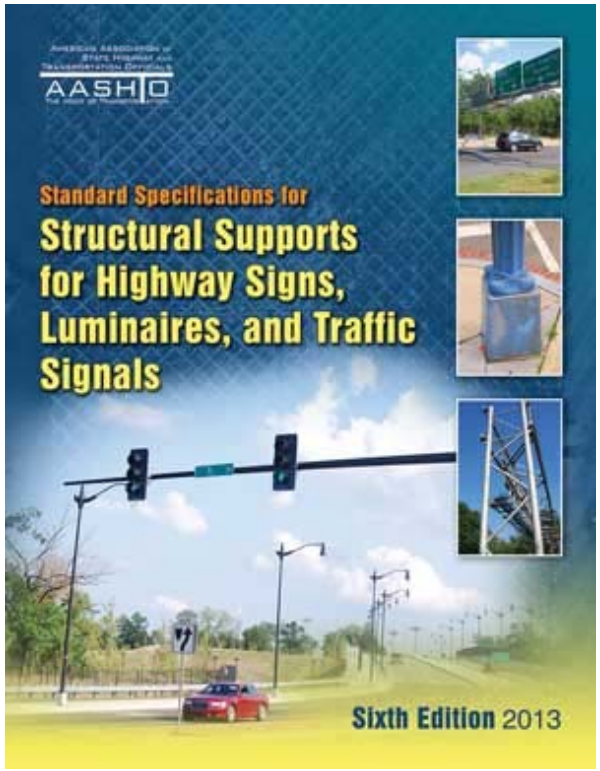
S. Roy
Y.C. Park
R. Sause
J.W. Fisher
E.J. Kaufmann
Advanced Technology for Large Structural Systems (ATLSS) Center
Lehigh University
Bethlehem, PA

Contractor's Final Report for NCHRP Project 10-70
Submitted March 2011

National Cooperative Highway Research Program
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Traffic

- **AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, Sixth Edition 2013, are applicable to the structural design of supports for highway signs, luminaires, and traffic signals**
- **Addresses fatigue design**
- **Fatigue was also addressed in the 5th edition from 2009 and was first addressed in the 4th edition in 2001**

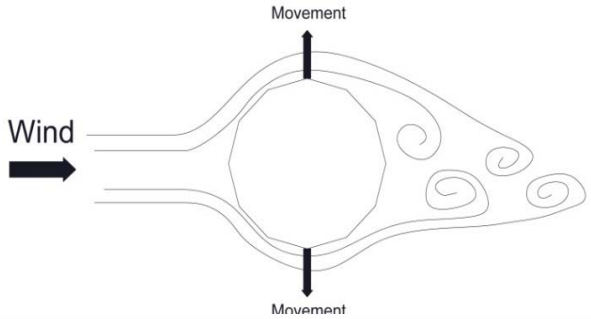


Fatigue - AASHTO

- **Section 11 of AASHTO requires fatigue design for high-mast lighting towers (HMLTs) over 55 ft**
- **NCHRP Report 412 is the basis for the fatigue design provisions for cantilevered structures**
- **For first time in this revision, HMLTs are differentiated from other types of structures for fatigue design and assigned an equivalent static pressure range**

Fatigue - AASHTO

- **According to AASHTO, high-mast poles can be highly susceptible to vibrations induced by vortex shedding, leading to the rapid accumulation of potentially damaging stress range cycles (depending on the fatigue detail category selected) that lead to fatigue failure**
- **Vortex shedding - the shedding of vortices on alternate sides of a pole exposed to wind may result in oscillations in a plane normal to the direction of wind flow**



Fatigue - AASHTO

- **Prior to 2013, HMLTs vortex shedding was addressed in a stand-alone separate article**
- **Rather than separate the effect of vortex shedding from all other wind phenomena, a loading spectrum has been developed to encompass all typical wind load effects for HMLTs**
- **Fatigue-limit-state static wind pressures are provided representing this combined wind load effect**

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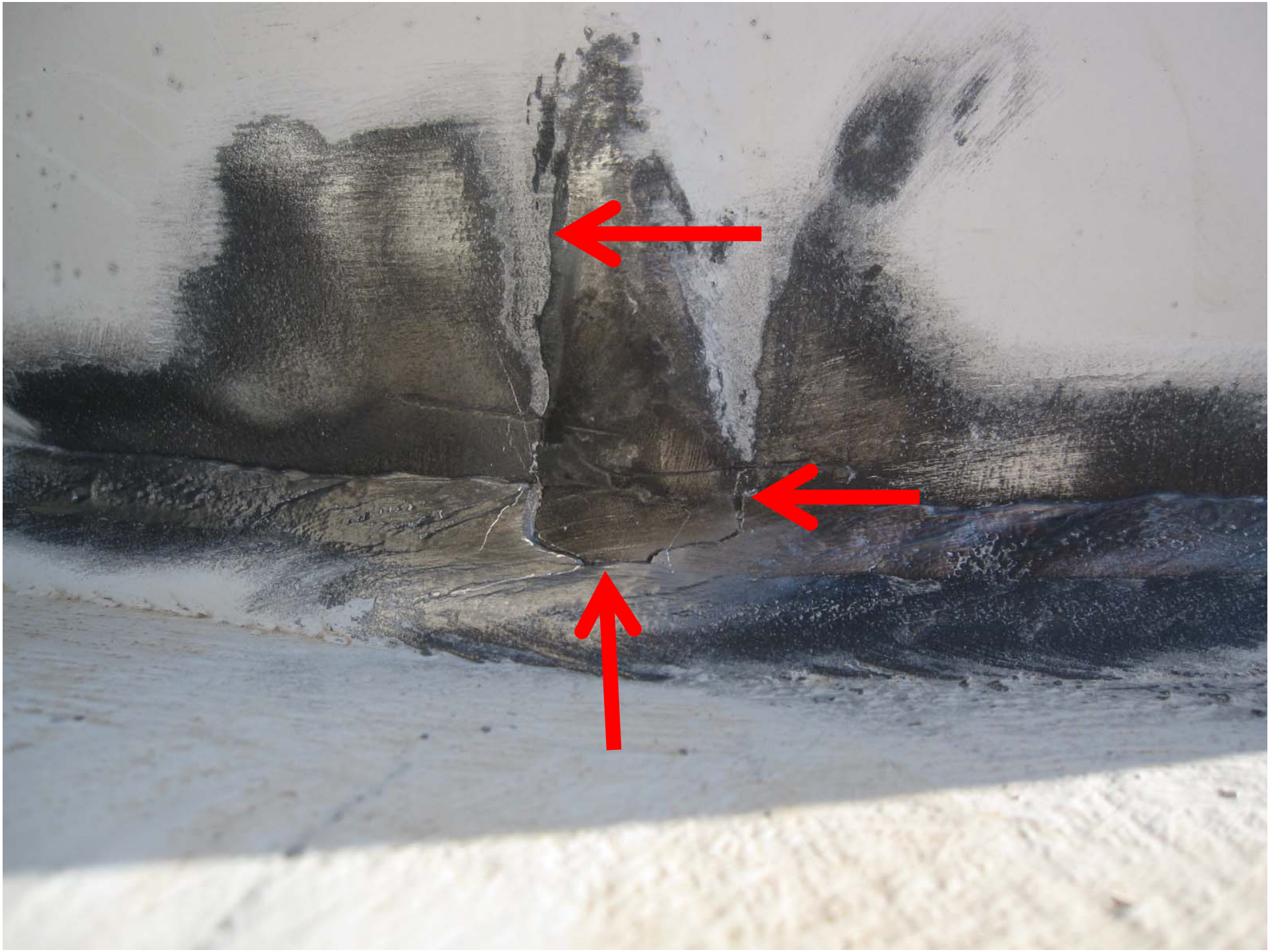
Small Wind Generation

- **Small wind turbine support structures – rotor swept areas less than 2,200 sq ft**
- **Popular application for small poles & towers; typically using structures similar to communications structures**
- **Is fatigue an issue?**



Small Wind Generation

- **TR-14, authoring body of TIA-222, will be releasing a Design Supplement to TIA-222-G for small wind turbine support structures**
- **Section 11 will address designing for fatigue strength**
- **Fatigue wind loading will be considered as an additional service loading combination using a 30 mph uniform wind speed**


ANSI/TIA-222-G-DS1-2011
DRAFT 10-23-2012 Rev 1

ANSI/TIA STANDARD
DESIGN SUPPLEMENT

Design Supplement for Small Wind Turbine Support Structures

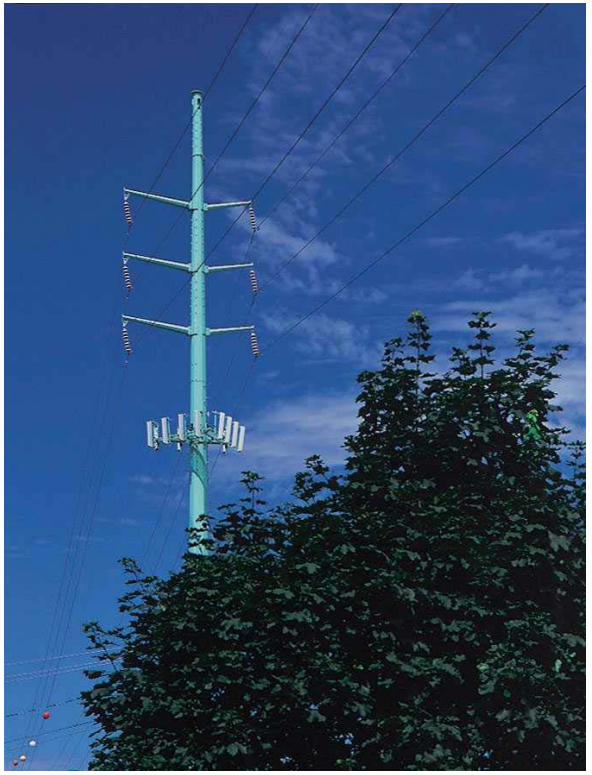
TIA-222-G-DS1 Draft 10-23-2012 Rev 1

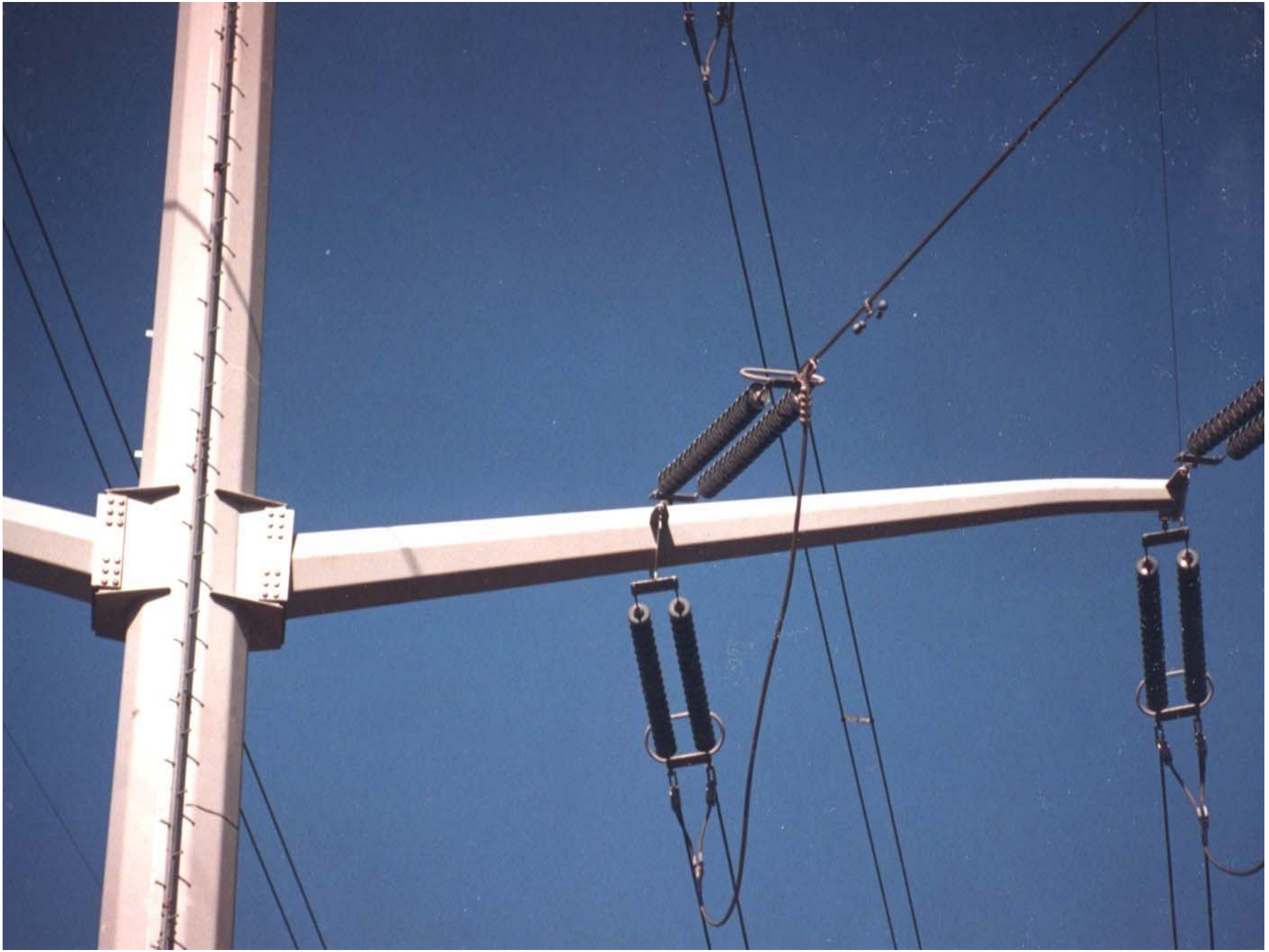
TELECOMMUNICATIONS INDUSTRY ASSOCIATION
TR14.7 Sub-committee

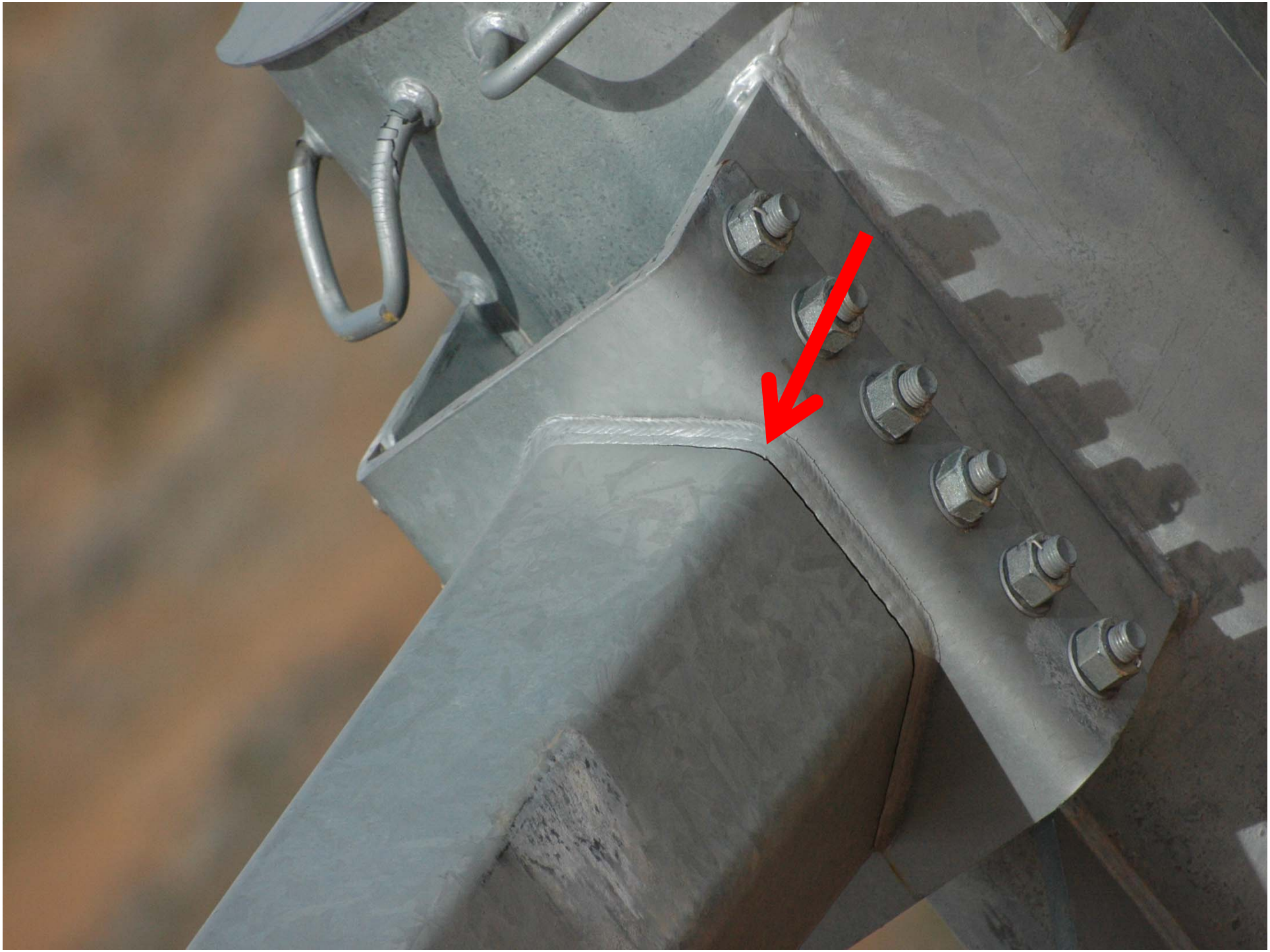
tiaonline.org

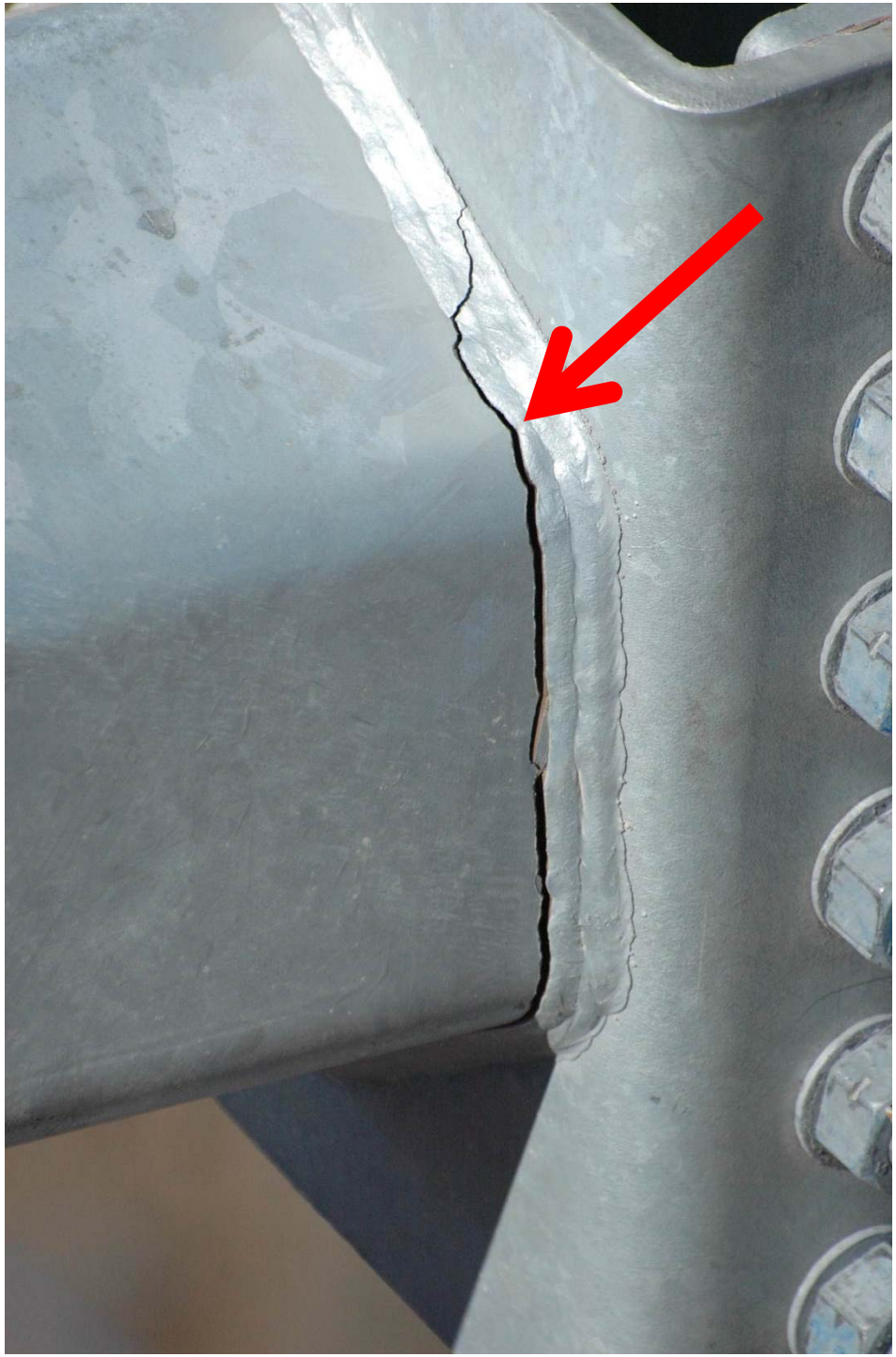
Electric Utility

- **Historically fatigue not considered during design**
- **Extensive use of polygonal poles, pole structures, and polygonal conductor arms since the ’60’s**
- **Is fatigue an issue?**









Electric Utility

- **Industry dealing with conductor arm fatigue issue**
- **Issue not limited to one manufacturer**
- **Issue can lead to extensive project delays and cost hundred of thousands of dollars**

Communications

- **Historically fatigue not considered during design**
- **Numerous appurtenances such as mounts, antennas, feedlines, and steps disrupt the wind which tend to eliminate vortex shedding and reduce fatigue occurrences**
- **Industry and age of structures relatively young**
- **Is fatigue an issue?**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3
2
1
18
Grout spacing

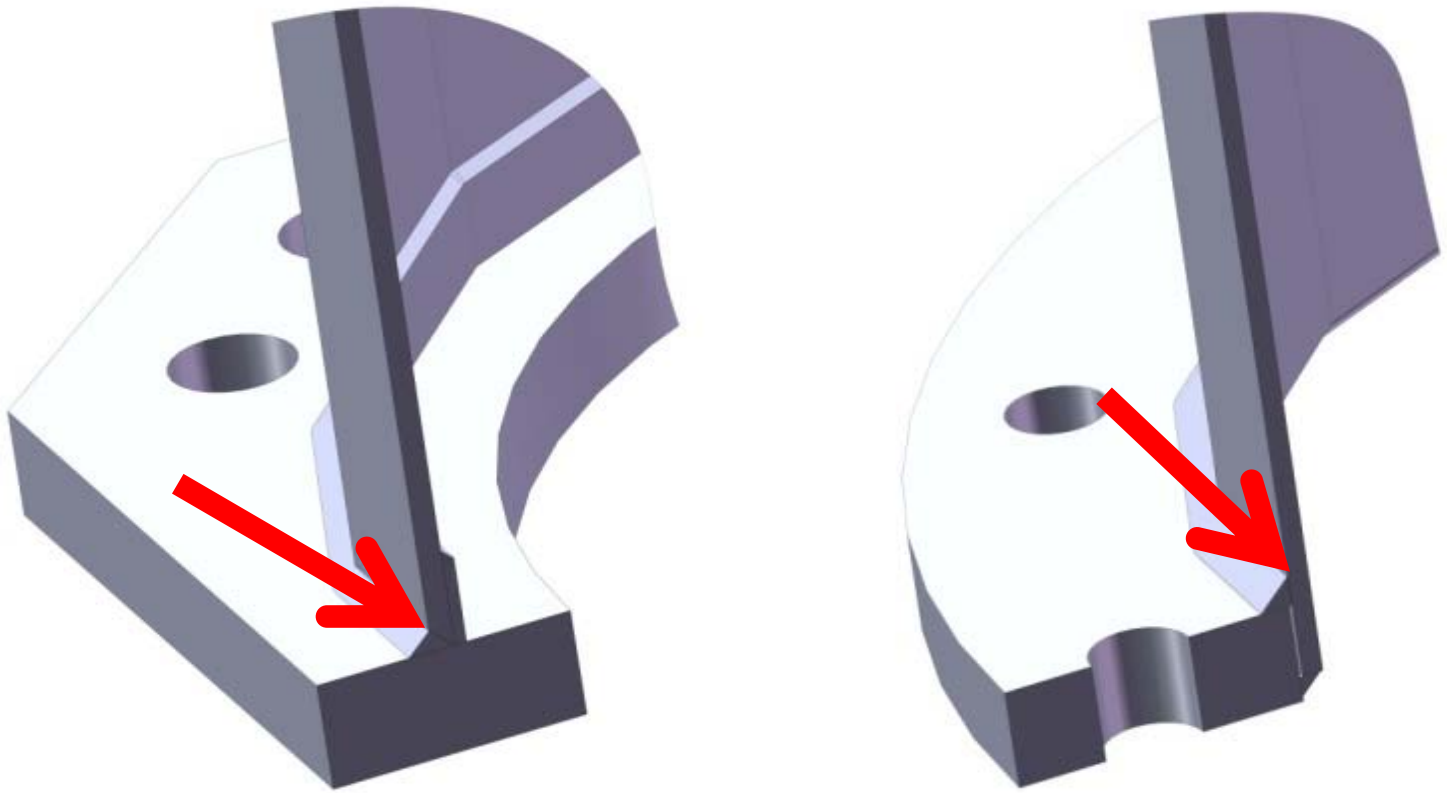
Communications

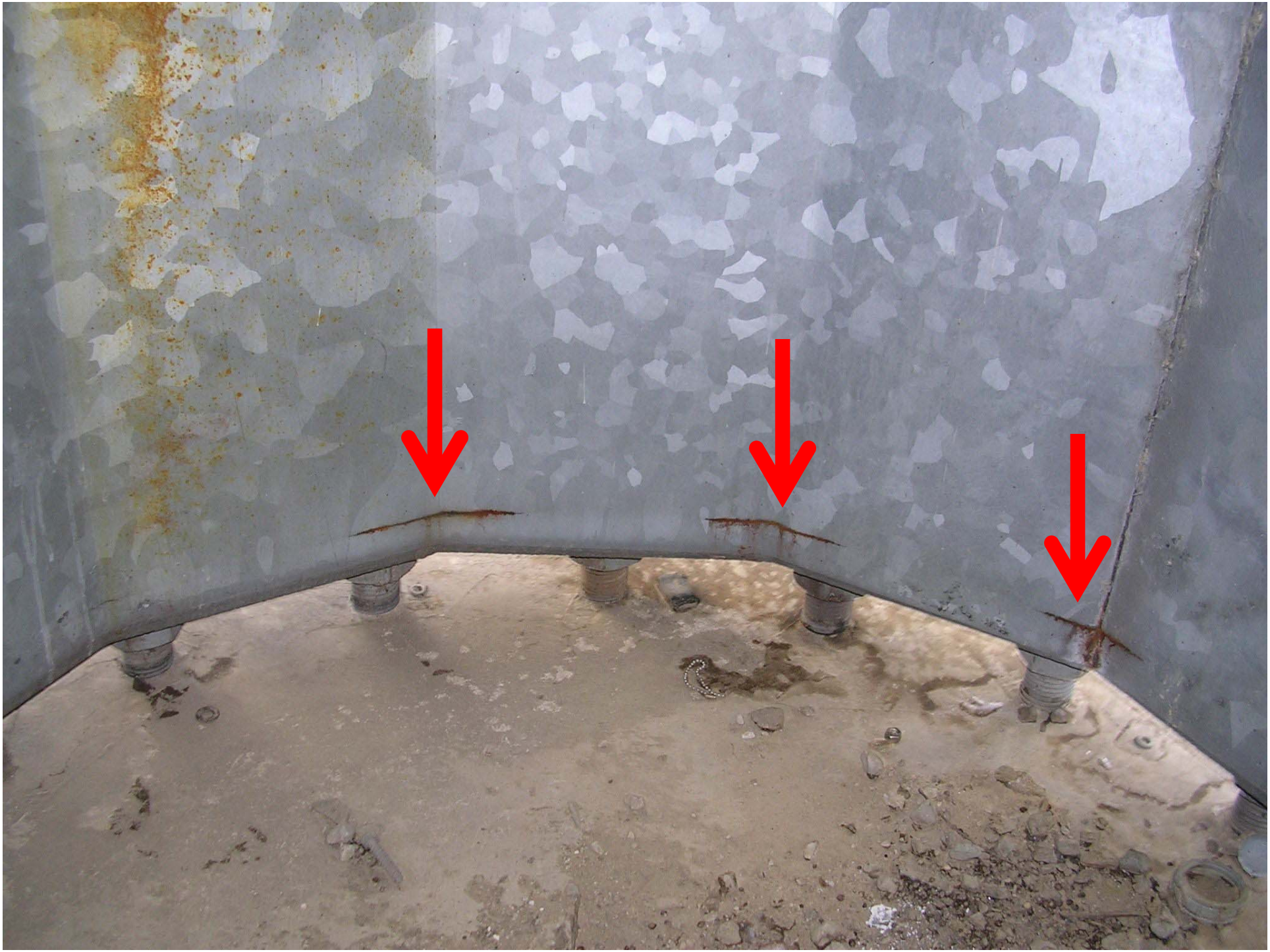
Areas of concern:

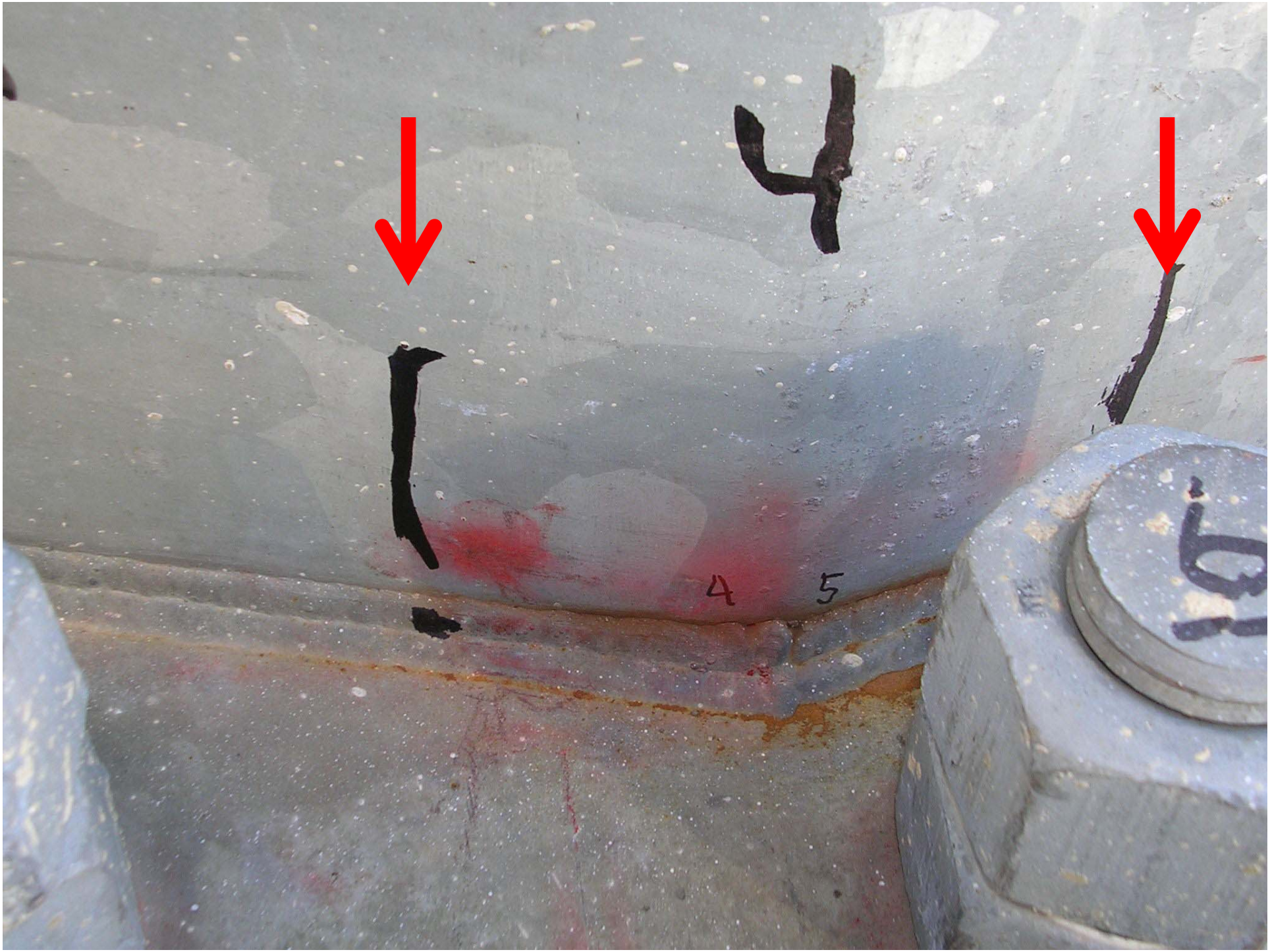
- ✓ **Base plate toe cracks (from fatigue or not)**
- ✓ **Loose anchor bolt nuts & leveling nuts**
- ✓ **Under-designed base plates**
- ✓ **Topography/wind speed-up**
- ✓ **Abrupt changes in structure diameter and stiffness**
- ✓ **Large arms (cross poles)**
- ✓ **Flagpoles without the flag**
- ✓ **Square cuts, square handhole frames**

Reese
TOWER SERVICES

Toe Cracks






4
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7


Grout
Out


CAUTION


705 Old Charlotte Hwy, Fairview, NC 28730, USA
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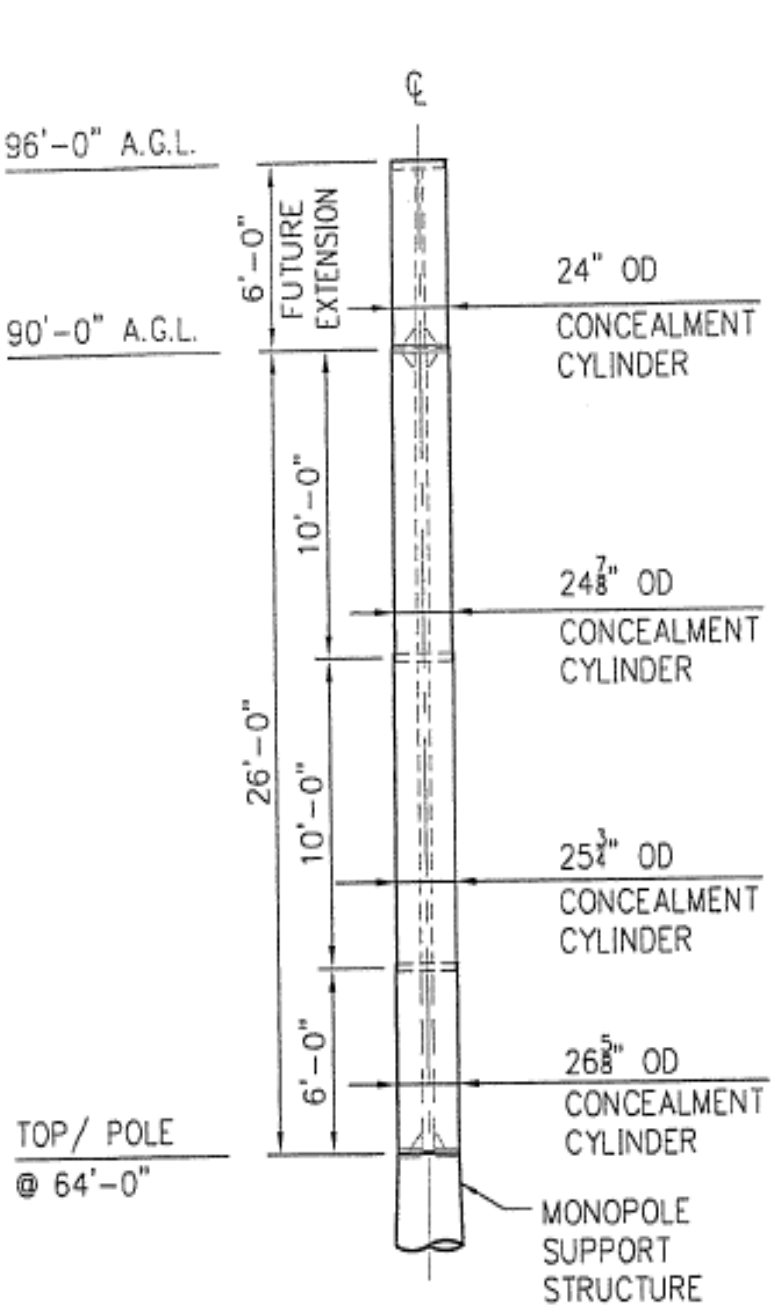
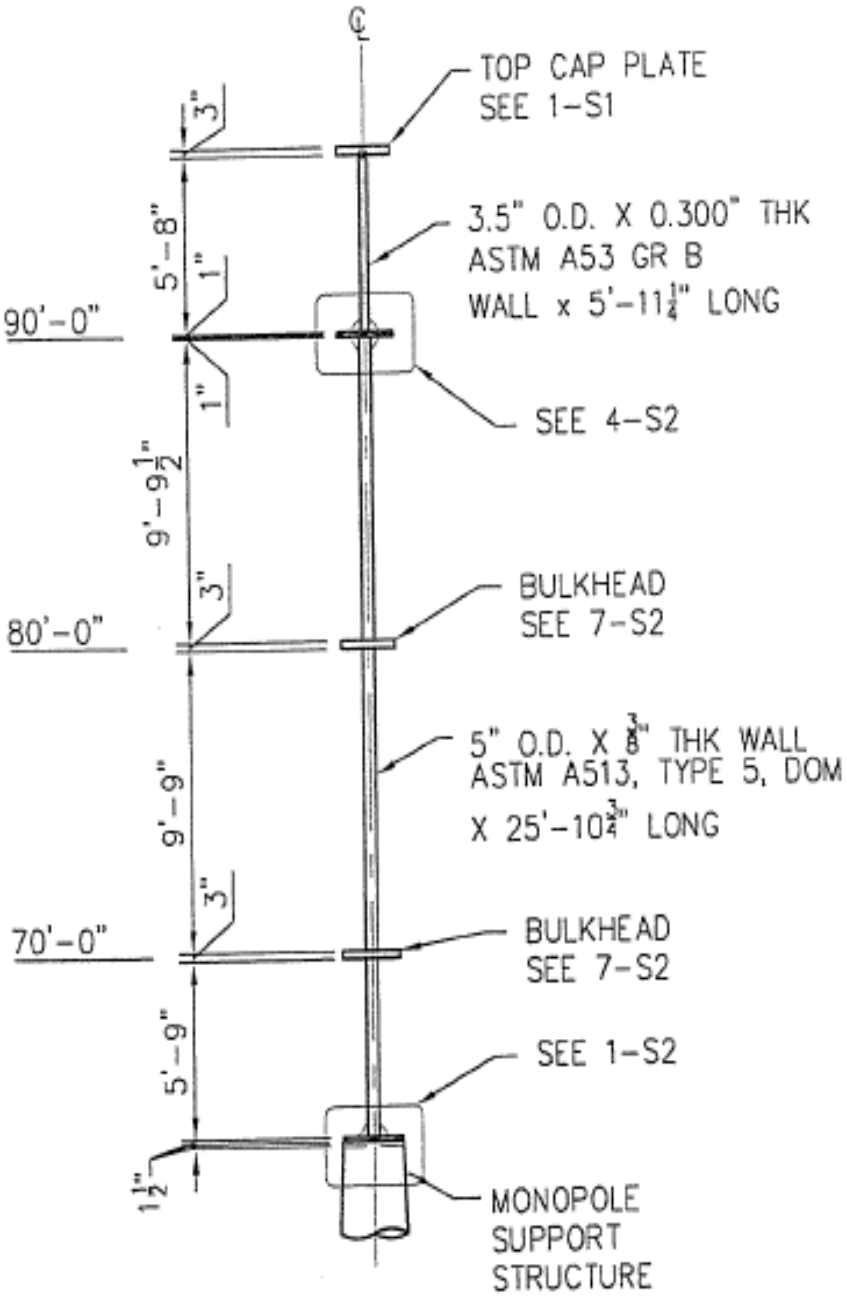
09/17/2012



CUST-3C-70-26 EXT
W/ CONCEALMENT CYLINDER



CUST-3C-70-26 EXT
W/O CONCEALMENT CYLINDER


10/25/2011


02/07/2013


2011.11.09

Summary

- **Tubular steel poles, arms, and mounts can be fatigue candidates**
- **Issues across all industries utilizing pole structures**
- **Fatigue fracture (failure) has other contributing issues**
- **Communications industry traditionally has not addressed fatigue**

Summary

Communications industry areas of concern:

- ✓ **Base plate toe cracks (from fatigue or not)**
- ✓ **Loose anchor bolt nuts & leveling nuts**
- ✓ **Under-designed base plates**
- ✓ **Topography/wind speed-up**
- ✓ **Abrupt changes in structure diameter and stiffness**
- ✓ **Large arms (cross poles)**
- ✓ **Flagpoles without the flag**
- ✓ **Square cuts, square handhole frames**