# **Electrical Transmission and Substation Structures 2022**

## Innovating for Critical Global Infrastructure

Proceedings of the Electrical Transmission and Substation Structures Conference 2022

Orlando, Florida, USA 2 – 6 October 2022

**Editor:** 

**Tim Cashman** 

ISBN: 978-1-7138-6201-7

#### Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2022) by American Society of Civil Engineers All rights reserved.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact American Society of Civil Engineers at the address below.

American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191 USA

Phone: (800) 548-2723 Fax: (703) 295-6333

www.asce.org

#### Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400

Fax: 845-758-2633

Email: curran@proceedings.com Web: www.proceedings.com

### **Contents**

#### Case Studies/Projects

A Tall Order: Duke Energy's NCSPA Project	1
Ganga Pontula, John Taylor, E. J. Benton, and Ben Wadsworth	
Protecting Steel Poles and the Environment! SR529 Mitigation—A Case	
Study on Environmental Factors and Steel Structure Preservation	13
Grant Leaverton, Justin Curtis, Aziz Haq, and Gordon Hayslip	
The Badger Coulee Transmission Line: Overcoming	
the Challenges of Wisconsin	24
Griffen Erickson, Michael Bradley, Cory Jacobsen, and Jacob Valentine IV	
380 m Ultra Long Span Crossing Tower: Design,	
Fabrication, and Construction	35
Yong Guo, Gangping Dai, Fuping Duan, Xiaofeng Ge,	
Dachang Zhang, and Bill Kong	
Design/Analysis	
A Structural Engineer's Perspective on Transformer Installations	55
Daniel S. Cuffman and Benjamin A. Roberts	
Cost and Performance of Guyed Lattice Structures vs.	
Self-Supporting Towers	70
Darel Tracy and Jared H. Smith	
If the Shoe Fits: Design of 765-kV Tower Base Plates	77
Adam G. Bowland, Josh Wright, and Aaron P. Darby	
Not So Good Vibrations—Design Considerations for Slenderness Limits	94
Adam G. Bowland, Josh Wright, and Aaron P. Darby	
Seismic Analysis of Transmission Towers—Case Study	103
Mohamed Khedr and Rozlyn Lord	
Overhead Transmission Line Structure Selection	116
Todd McMillan and Aaron Darby	
Tubular 3D Frames for Long Span Transmission Structures	129
Anthony J. Hansen, Donghui Yuan, William Reisdorff, and Diaaeldin Mohamed	

#### **Foundations**

Full Scale Direct Embed Steel Pole Load Test	144
Key Considerations for Managing Risk When Implementing Vibratory Caissons Nathaniel Schrein, Darren Campbell, Choo Keong Ong, Bradley Gardner, Justin Lightner, and David G. Hancock	159
Alternate Foundation and Structure Designs: Mississippi Backwater Construction Challenges Simon C. Murley, Christopher M. Strom, and Jason W. Herron	170
Lattice Towers	
A Renaissance in Tower Testing  Katherine Bridwell, Ronald Carrington, and John Siegel	184
Fall Protection and Walkability: Analytical Methodology for Lattice Towers Sathish Konduru and Rebecca Knowlton Fournier	196
Fragility Analysis of Transmission Tower-Line System under Multiple Environmental Loadings William Hughes, Wei Zhang, and Qin Lu	207
Loadings	
Designing Overhead Transmission Lines to Withstand Snow Avalanches	223
Is My Substation Ready for the Next Extreme Event?	235
Wind Loading Considerations in Transmission Line Design	244
Managing Aging Infrastructure	
Challenges in Analysis of 100 Year Old River Crossing Structures	259
Housatonic River Crossing Replacement: Transmission Line Deconstruction Gets Creative  Marc Phillips and John Rector	270

Keeping It Close: A Composite Solution to Rebuilding a 69 kV Line	79
Test Methods for Serviceability Assessment of Non-Traditional Steel Support Structures	91
Posters	
A New Approach to Substation Structure Foundation Design	02
Adaptive Foundation Design of Power Lines Reduces Schedule and Coordination Challenges of Field Geotechnical Investigations	10
Aesthetics in Powerlines: Why It Matters	21
Considerations in Guyed Engineered Steel Structure Design	27
Experimental Study on the Effect of Gusset Plates' Geometry on the Behavior of Steel Lattice Transmission Line Tower Connections	37
Hurricane Fragility Analysis of Electrical Transmission Towers	48
Influence of Steel Pole and Davit Arm's Deflection on Clearance to Structure Calculations	58
Optimization of Transmission Line Structures Using Braced Post Insulators	66
Prediction of Modal Response of Towers Using Artificial Neural Networks	93
Properties and Performance of Ductile Iron Poles	04
Response Spectrum for Short Circuit Loads on Rigid Bus4  Josh Baker	14

Seismic Risk Assessment of the Electrical Substations in Colombia of ISA, the Largest Energy Transmission Company of Latin America425 Susana Galeano-Báez and Ana Beatriz Acevedo
Short-Circuit Forces, Load Factors, and Ultimate Strength: Clearing Up Confusion
SEI/ASCE Overhead Line Loading Standard
ASCE/SEI Overhead Line Loading Standard: Special ETS 2022 Session
Special Design Considerations
Cathodic Protection Solutions for Electric Utility Structures
Engineering Considerations for Helicopter Construction  Methods Learned on the Cricket Valley 345 kV Project
Transmission Structures Exposed to Water Flow: Resiliency and Risk Mitigation
Substations
Damping Devices for Seismic Protection of Substation Equipment
Development of a Vortex-Induced Vibration Analysis  Process and Evaluation of Fatigue Damage Risk
Practical Application of EPRI Research for Computing Fault Current Forces536 Martin Hughes, Matthew Bosworth, Jose Blanco, Ian Hodgson, Andrew Zorn, and David Birrell
Strain Bus Short Circuit Force Background, Accuracy, and Design Impacts548 Alex J. Kladiva
Wildfires
Does Compliance with Minimum Regulatory Standards Adequately Mitigate Wildfire Risk?

Evaluation of Structural Materials to Maximize	
Infrastructure Survivability in Wildfires	575
Clinton Y. Char, Brian Flynn, and Sergio Arambula	
Fire Testing of Concrete and Steel Electric Utility Poles	596
Fouad H. Fouad, Mark Ackerman, and Ronald Barnett	
Minimizing Wildfire Risks through Advanced	
Structural Inspection and Modelling Techniques	609
Hannling Shaw and John Makkar	