



Wood Pole Structures for Electrical Transmission Lines

RECOMMENDED PRACTICE
FOR DESIGN AND USE

Task Committee on
Recommended Practice for
Wood Pole Structures for
Electrical Transmission Lines

ASCE



Wood Pole Structures for Electrical Transmission Lines

Recommended Practice for Design and Use

Prepared by the
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Wood Pole Structures for Electrical Transmission Lines of the
Structural Engineering Institute of the
American Society of Civil Engineers

Edited by
James M. McGuire, P.E.,
Otto J. Lynch, P.E.,
Vicki Schneider, P.E.,
Jaron T. Reay, P.E., S.E.,
Timothy P. Wachholz, P.E., S.E.,
and Nelson G. Bingel III

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PREFACE

The purpose of this manual is to provide the reader with a basic knowledge of the principles and methods for the design and use of wood poles for overhead utility line structures. This manual is the result of a multiyear collaborative effort by engineers and technical experts from electric utilities, consulting firms, academia, and manufacturers engaged in the design and application of these structures.

Every effort has been made to ensure the accuracy and clarity of this document. The user is reminded that utility line structures are an integral part of a larger overhead line system and therefore cautioned that the application of these structures should come only after sound engineering judgment has been applied. Furthermore, as an overall treatise covering a wide variety of line applications, this document cannot conceivably satisfy all conditions. The user should be reminded that often there will be specific local conditions and requirements that may dictate design and usage conditions that differ from those described herein.

The task committee is grateful for the dedicated effort of all who participated in the development of this manual.

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ASCE Task Committee on Recommended Practice for Wood Pole Structures for Electrical Transmission Lines

James M. McGuire, P.E., *Chair*
Otto J. Lynch, P.E., *Vice Chair*
Vicki Schneider, P.E., *Secretary*
Yair Berenstein, P.Eng.
Nelson G. Bingel III
Ryan Bliss, P.E.
Clinton Char, P.E.
Thomas J. Christy, P.E.
Robert Erickson
Jim Fixsen, P.E.
Kristie Jackson Green, P.E.
Justin L. Johnson, P.E.
Devang L. Joshi, P.E.
Robert Kluge, P.E.

Kishor Kumar
Michael D. Miller, P.E.
Jeffrey J. Morrell
Thad A. Mumm, P.E.
Rob Nelson
David E. O'Claire, P.E.
Wesley J. Oliphant, P.E.
Jaron T. Reay, P.E., S.E.
Erik A. Ruggeri, P.E.
Katie Shaddix, P.E.
Larry Vandergriend, P.E.
Timothy P. Wachholz, P.E., S.E.
Kimberly Waggoner, P.E.
Vahid Zakeri, P.E.

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Gary Bowles, *Chair*
Mark Jurgemyer
Martin Rollins
David Endorf, P.E.
Stacey W. Sheffield, P.E.

Bryce Barton, Ph.D., P.E.
Terry Burly
R. Dan Seale
Steven G. Walker, P.E.

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DEFINITIONS

ANCHOR GUY: Guy wire attached to a wood pole structure on one end and an anchor installed into the ground on the other end, to provide increased strength and/or stability to the transmission structure and foundation system.

ANGLE STRUCTURE: Structure where the conductor direction changes. This structure supports similar vertical and transverse loads as a **TANGENT STRUCTURE**, as well as significant transverse loads resulting from wire tensions being applied at an angle.

BACKFILL: Material such as soil or crushed stone that is placed to fill an excavation and provide support to the foundation system.

BUCKLING: Failure of the wood pole or other structural member to resist the applied compressive stress in its current geometric shape.

CLEARANCE: The clear distance between two objects measured surface to surface.

CONDUCTOR: A wire or cable suitable for and intended to carry electric current.

CONNECTION: The method by which loads are transferred between structural members or components.

DEAD-END STRUCTURE: Structure designed as a termination point for wires and capable of supporting the full tension loads of all wires removed on one face.

DESIGN LOADS: The loads that the structure is designed to support, comprised of **NOMINAL LOADS** multiplied by a specified **LOAD FACTOR**.

DESIGN STRENGTH: The capacity of a structural member to resist the **DESIGN LOADS**. It is calculated by multiplying the **NOMINAL STRENGTH** by the appropriate **STRENGTH FACTOR**.

DIRECT EMBEDDED POLE: A structure that utilizes the lower section of the pole as the primary foundation system by setting it a specified distance below groundline.

ENGINEER: An agent of the owner who is responsible for the design and is qualified by engineering education, experience, and/or professional registration to complete the design.

FRAMED STRUCTURE: Any multipole structure that is constructed using crossarms, braces, or other structural members. A simple frame structure uses only a crossarm that is pinned to each pole, whereas a braced frame structure uses knee, vee, and/or X-braces to increase the structure stiffness and capacity to support the DESIGN LOADS.

GROUNDING SYSTEM: A CONDUCTOR or system of conductors intended to provide a path for electric current to travel to earth.

GROUNDLINE BENDING MOMENT: Moment resulting from horizontal and offset loads applied at heights aboveground.

GUYED STRUCTURE: Any structure that relies on SPAN GUY wires or ANCHOR GUY wires to provide the necessary strength and stability to the structure or foundation system to support the DESIGN LOADS.

INSULATOR: Structural member composed of insulating material and designed to support a conductor physically while providing the required electrical CLEARANCE to other structural members.

JOINT USE STRUCTURE: Any structure that supports the facilities of two or more entities.

LAMINATED UTILITY STRUCTURES: Glued laminated timber structures that are an engineered, stress-rated product of a timber laminating plant and made up of assemblies of specially selected and prepared wood laminations securely bonded together with adhesives. The grain of all laminations is approximately parallel longitudinally. They may comprise pieces end-joined to form any length or pieces placed or glued edge-to-edge to make wider pieces.

LOAD FACTOR: A multiplier used with NOMINAL LOADS to introduce a level of reliability to the design and establish the DESIGN LOADS.

NOMINAL LOADS: Forces that result from meteorological conditions, physical configuration, construction activity, weight of structural members, wires, and equipment.

NOMINAL STRENGTH: The calculated capacity of a structural member to resist the effects of applied loads. This capacity is multiplied by a STRENGTH FACTOR to determine the DESIGN STRENGTH of the structural member.

OVERLOAD FACTOR: See LOAD FACTOR.

OWNER: The person, entity, or designated representative responsible for the design, fabrication, installation, purchase, and maintenance of the transmission structure.

QUALITY ASSURANCE: Administrative and procedural activities implemented in a quality system to minimize or prevent mistakes, problems, and deficiencies and fulfill quality requirements and goals for a product, service, or activity.

- QUALITY CONTROL:** The process by which individuals or entities review and test the quality of each aspect of a product, service, or activity to uncover defects.
- RAKE:** The amount of horizontal pole top displacement created by installing a pole tilted out of plumb. It is used to visually counteract pole deflection such that the pole will appear plumb under a specified load condition.
- SELF-SUPPORTING STRUCTURE:** Any structure that is capable of providing the necessary strength and stability to support the DESIGN LOADS without the aid of an ANCHOR GUY, SPAN GUY, or other external restraint.
- SHIELD WIRE:** Wire installed above the conductors for lightning protection and fault current return. Other terms commonly used include static wire, overhead ground wire, and optical ground wire (OPGW).
- SPAN GUY:** Guy wire attached to a structure on one end and another supporting structure on the other end, to provide increased strength and stability to the transmission structure.
- STRAIN STRUCTURE:** Structure similar to a DEAD-END STRUCTURE, where wire tensions are transferred directly to the structure but capable of resisting only unbalanced/differential tensions with all wires intact.
- STRENGTH FACTOR:** A multiplier used with the NOMINAL STRENGTH of a structural member to account for variations in the material properties, introduce a level of reliability to the design, and establish the DESIGN STRENGTH.
- STRUCTURE FRAMING DRAWINGS:** The drawing set prepared by the ENGINEER that contains the details and specifications necessary for the proper assembly and erection of the wood pole structure.
- TANGENT STRUCTURE:** Structure having minimal line angle. This structure primarily resists the vertical weight of the wires and any accumulated ice and the transverse loads caused by wind.
- THROUGH-BORING PROCESS:** Process that involves boring many small holes through the pole in a specific pattern at the groundline zone before application of the wood preservative. This process allows the preservatives to penetrate the heartwood of the pole and saturate the wood material in the groundline zone, providing enhanced protection against wood decay.
- WIRE:** All electrical conductors, shield wires, optical ground wire (OPGW), messengers, and communication cables attached to a transmission structure.

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CHAPTER 1

STRUCTURAL CONFIGURATIONS AND POLE APPLICATIONS

1.1 GENERAL

Round wood poles have been used as structural members for centuries and account for most overhead utility line construction. Trees are a renewable resource, are readily available, and when harvested can be treated with preservatives that help resist decay. Utility workers can climb wood poles; the poles are nonconductive and easily modified in the field by drilling or sawing.

Utility lines can also be constructed using poles manufactured from other materials. The material chosen depends on considerations such as cost, availability, performance, and preference. When wood poles are selected as the primary structural component, it is essential that the appropriate material properties are accounted for during the design process. The species, original preservative treatment, pole length, class, and embedment depth are important aspects of design.

Consideration should also be given to the type of application and structure configuration that will be used. Designing structures based only on the pole's bending strength may not be adequate for applications requiring guyed structures or switch structures, where buckling strength and deflection should also be considered. Different species are more readily available in certain areas and have unique strengths and characteristics that may dictate the preferred material type for specific applications.

In some instances, a rule of thumb is used to install or select poles and design wood pole lines. This approach does not ensure sound engineering practices are followed. The information in this manual is intended to give the reader basic knowledge of the principles and methods for the design