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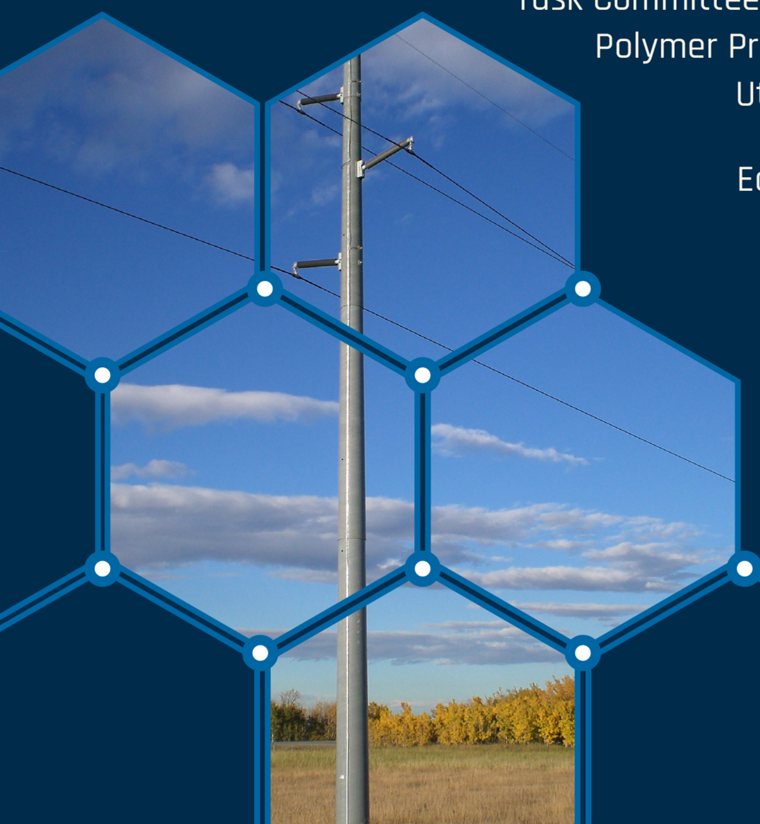
RECOMMENDED PRACTICE FOR FIBER-REINFORCED POLYMER PRODUCTS FOR OVERHEAD UTILITY LINE STRUCTURES

SECOND EDITION

Task Committee on Fiber-Reinforced
Polymer Products for Overhead
Utility Line Structures

Edited by Galen Fecht



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Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures

Second Edition

Prepared by the
Task Committee on Recommended Practice for
Fiber-Reinforced Products in Overhead Utilities
Line Structures of the Structural Engineering Institute
of the American Society of Civil Engineers

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(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however, nor is it so elementary or so conclusive as to provide a "rule of thumb" for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person's observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each manual shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, so that its merit may be definitely understood.

In February 1962 (and revised in April 1982), the Board of Direction voted to establish a series titled "Manuals and Reports on Engineering Practice," to include the manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such manual or report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past manuals. Numbering would be consecutive and would be a continuation of present manual numbers. In some cases of joint committee reports, bypassing of journal publications may be authorized.

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PREFACE

INTRODUCTION

Background. This manual of practice is intended to provide direction and guidance in selecting fiberglass reinforced polymer (FRP) composite utility line components, namely poles and crossarms. It covers poles and crossarms manufactured by currently available processes using FRP materials. The range of pole and crossarm applications includes distribution and transmission line structures. This book does not cover FRP lattice structures, conductors, insulators, stand-offs, or other FRP components used in the electrical grid.

The first major attempt to provide guidance to the utility industry in the selection and use of FRP utility structures was completed by the initial ASCE Task Committee on FRP Overhead Utility Line Structures. The output of that committee resulted in a document titled ASCE 104 *Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures*. This document was intended to introduce the subject of FRP utility line structures and serve only as a guide regarding selection and use. It was not created as a prestandard or as a standard. It also only covered pole structures and did not include crossarms. At the time it was written and published, there were very few other guides in use for FRP components, and few utility specifications had been written to include FRP poles or crossarms for utility line structures. In addition, FRP poles and crossarms were not specifically recognized by the National Electrical Safety Code (NESC) up through the NESC 2002 edition.

In this time frame, the use of FRP utility poles and crossarms was growing, even without inclusion in the NESC. However, it was clear that most utilities and cooperatives relied heavily on the NESC for direction, so it was imperative that to manage the informed growth of FRP utility poles and crossarms, recognition by NESC was necessary.

In late 2005 and early 2006, recognition by the NESC governing body that the use of FRP utility poles and crossarms had matured sufficiently to be included in the code led the NESC governing body to approve the inclusion of FRP poles and crossarms in the next edition, which was NESC 2007. Based on a long history of low coefficients of variation in product performance combined with favorable installed line performance history, the strength factors of FRP poles and crossarms were recognized in NESC 2007 to be the same as other engineered materials, namely steel and prestressed concrete.

Around the same time that composite utility poles were receiving official recognition in the NESC, similar efforts were underway in Canada. In 2006, the Canadian Standards Association (CSA) adopted composite utility poles into the CSA C22.3 No. 1, Overhead Systems standard for the first time, allowing composite utility poles to utilize the same minimum load factors as steel poles, providing that the composite pole manufacturers rated their pole strengths as 5% lower exclusion limit (LEL) values and through ongoing testing could verify a coefficient of variation (COV) of 10% or less for their product. In addition, the Center for Energy Advancement through Technological Innovation (CEATI) International Inc. hired a consultant to develop the *Guide for the Use of Composite Poles, Crossarms and Braces* for the major Canadian and US utilities that are members of CEATI.

Task Committee History. In 2006, following the acceptance of FRP utility poles and crossarms into the soon-to-be-published NESC 2007, there was still no US publication available for use by the utility industry to ensure appropriate standardized pole and crossarm design, manufacture, and performance. Therefore, in mid-2006, it was determined that a new task committee effort needed to be organized with the purpose of generating a document for the design, selection, purchase, and installation of FRP overhead utility line structures.

This need culminated in the organization of an ASCE Task Committee for FRP Overhead Utility Structures as of October 1, 2006, with the first meeting held in Birmingham, Alabama, on October 19, 2006. This committee was organized under the Electrical Transmission Structures (ETS) Committee of ASCE.

The efforts of the 2006 FRP committee resulted in a near-complete document on November 5, 2008; however, the document was neither reviewed nor published. In 2013, the FRP committee was reinstated with the first meeting held in Boston, Massachusetts, on April 3, 2014.

USE OF THIS MANUAL

Many references in this Manual of Practice (MOP) advise the user to consult with FRP component manufacturers. Although this MOP has been authored with the intent of covering the generalities of FRP component consideration and usage, because of the variety of input materials, manufacturing methods, and resulting finished goods, a necessary step in working with a given FRP component is consulting with that component's manufacturer to confirm its attributes and allowable stress limits. Furthermore, once these characteristics are known and understood, the specific FRP component can be integrated into a utility's existing overhead line design standards, where a manufacturer's input may only be required for deviations from the established design standard.

CHAPTER 1
STRUCTURES AND APPLICATIONS

1.1 INTRODUCTION

Fiber-reinforced polymer (FRP) utility structures are not new to the electric power industry, nor is the use of FRP materials. Many products used by the industry are made of or incorporate FRP materials, including poles, ladders, grating, construction tools, lift-truck booms, transformer pads, hot sticks, bus bar supports, insulators, pole line hardware, and crossarms. Lighting poles made entirely of FRP materials have been used for decades; by the late 1990s, installations of FRP lighting poles numbered in the millions. Also by that time, electric utilities had installed a growing number of FRP poles designed to support power and telecommunication lines. The earliest FRP distribution poles were installed in Hawaii on the island of Maui in the mid 1960s. These first-generation FRP poles withstood high UV exposure, a corrosive island environment, and strong winds and performed reliably for approximately 45 years. Current FRP poles have vastly improved UV-protection systems over first-generation FRP pole offerings, which has provided great improvements in service life.

FRP materials are used widely in many applications because they can be engineered to offer important advantages over traditional materials. Such advantages include excellent reliability in high-load events, a high strength-to-weight ratio (lightweight), low maintenance, electromagnetic interference (EMI) and radio frequency (RF) transparency, dimensional stability, high dielectric strength/safety, fire resistance, environmental stability (inert, non-leaching material), and resistance to rot, corrosion, chemicals, and pest damage. Good examples of these benefits are cellular communications system enclosures on buildings (lightweight, RF transparency); fencing, handrail, and stair systems for hotel buildings/industrial complexes/offshore platforms (rot/rust resistance, low maintenance); grating, handrails, and structural platforms in copper-processing plants and wastewater treatment facilities (rust/chemical resistance, low maintenance, easy installation); third-rail cover boards and grating for metropolitan light transit systems (high dielectric strength/safety, rot/rust resistance); structural framework for field-erected cooling towers (high strength-to-weight ratio, rot resistance, easy installation); and grating and handrails for offshore oil drilling platforms (lightweight, rust resistance, low maintenance). The list of benefits goes on and on for the users of FRP products.

FRP materials also offer product engineers extraordinary design latitude. Engineers can choose from a wide range of material systems and processing techniques. This degree of flexibility distinguishes FRP materials from traditional materials like wood, steel, and concrete. The benefits and limitations of a finished FRP product largely depend on the material composition, the selected manufacturing process, and the relationship between the two. In fact, the relationship between materials and process is a more significant consideration with FRP products than with products made of traditional materials. The design flexibility, light weight, and durability of FRP materials is the reason FRP bridge decks are replacing concrete bridge decks on some vehicular bridges such as lift bridges, truss bridges, and other structures where weight, durability, and speed of installation are very important. Additionally, FRP materials' unique benefits have resulted in FRP rebar and FRP grating panels replacing steel rebar for reinforcing concrete bridge decks. The design flexibility of FRP products also applies to transmission structures and poles. Unlike poles made from traditional materials, FRP poles are available in a wide range of geometric shapes, colors, and surface textures, which provide additional solutions to asset owners.

Advancements and innovations in FRP materials and process technologies have resulted in lightweight, high-strength FRP materials that are more cost-competitive with traditional construction materials such as wood, steel, and prestressed concrete. While there are a variety of possible structural applications for FRP materials, this document focuses primarily on FRP poles and crossarms.

1.2 WHEN TO USE FRP COMPOSITE COMPONENTS

The power utility grid covers almost every corner of the earth and, as such, must endure many challenges—from initial construction hurdles, including topography and ground conditions, to in-service issues, including everything from extreme weather such as ice storms and hurricanes to everyday conditions such as salt environments near oceans or ice control on winter roads. Even woodpeckers and soil pH levels need to be considered in a hardened grid strategy.