TRANSMISSION &DISTRIBUTION WORLD

Composite Poles Support the "Circuit of the Future"

A Southern California Edison analysis indicates new pole materials provide lower total owning costs on its distribution system.

By **Mikel Rodin**, *Southern California Edison*

SOUTHERN CALIFORNIA IS KNOWN FOR ITS BEAUTIFUL WEATHER. What is less generally known is how downright inhospitable the California environment can be to an electric utility's infrastructure. Nowhere is this more evident than in the case of the ubiquitous utility pole. As every transmission and distribution engineer knows, pole installation and maintenance represent a major cost factor for utilities.

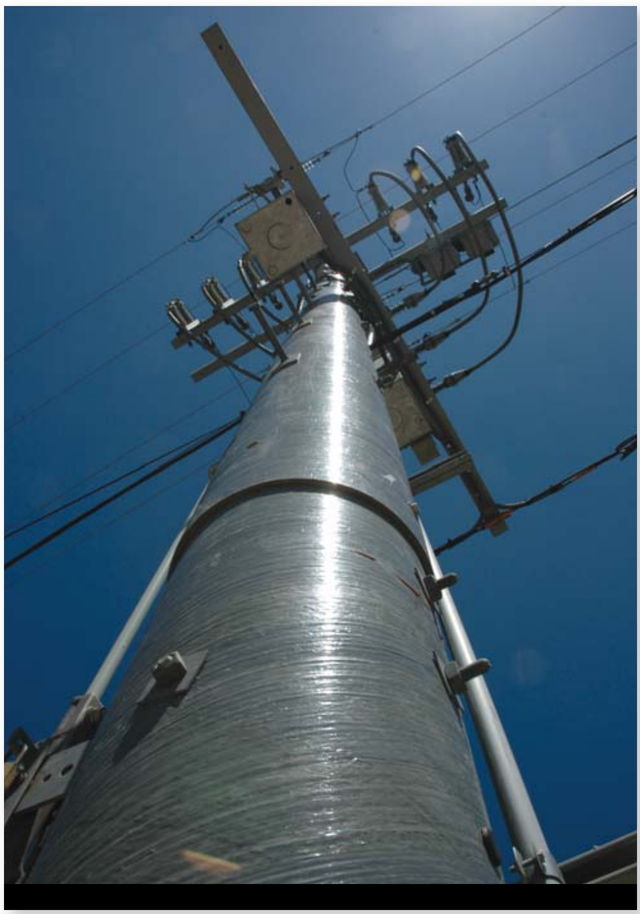
The effects of weathering, termites, rusting, high winds and fires take a toll on utility support infrastructure every year, which of course drives up maintenance costs, increases circuit interruptions and reduces overall system reliability. If a way could be found to mitigate these problems effectively, maintenance costs could be lowered and overall grid reliability improved.

Significant advancements have been made in the design and manufacture of transmission and distribution poles using new high-strength fiberglass fibers and polyurethane resins. Working with several composite-pole manufacturers, Southern California Edison (SCE; Rosemead, California, U.S.) has been deploying various types of composite poles to specific locations in its service area to evaluate their performance. SCE recognizes that composite poles manufactured with the new materials hold promise for dramatically reducing pole life-cycle maintenance and the need for frequent pole replacements, even for reasons other than age. These improvements also hold promise for reducing the initial cost of setting a pole as well as reducing the need for pole replacements.

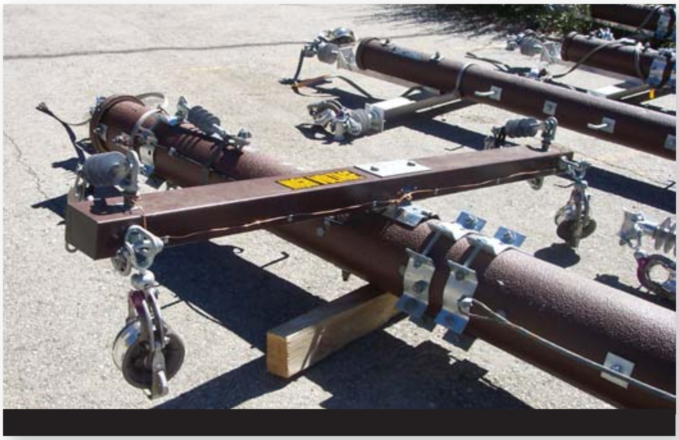
FIRST THERE WAS WOOD

The first electric utility poles used to support telegraph lines in the 19th century were from old forests. These trees were typically very dense and resilient hard woods. Today's rapid-growth tree farms produce poles that are, of course, still wood. However, there is some degradation in the properties of rapid-growth poles: reduced durability, stiffness and longevity. This means the new poles are less robust and do not resist insect infestation or wood rot as well and, therefore, have a shorter service life.

To enhance pole longevity, today's wood poles are



This modular composite pole is installed in San Bernardino, California, on the "Circuit of the Future." (Photo by Kevin Coates.)



These composite poles are framed with composite crossarms ready for helicopter transport to the mountainous installation location.

treated with chemicals, such as Pentachlorophenol, suspended in a light oil as the vehicle or carrier to deliver the chemical treatment. This eventually presents utilities with a handling and disposal challenge when the poles reach the end of their service life, because the treated wood poles may fail hazardous-waste criteria. When treated wood is deemed hazardous, it cannot be abandoned in the field; it must be disposed of in specially permitted landfills. This practice increases ownership expense. Over time, it is likely that these disposal restrictions will become stricter.

However, aside from wood rot or wood-boring insects, wood poles have a vulnerability that is especially problematic in California — they burn. This is where composite poles have a distinct advantage, as they are fire resistant and will not support combustion without the addition of an external heat source.

COMPOSITE CHARACTERISTICS

While not fireproof, composite poles are extremely fire resistant, particularly when coated with fire retardant. A propane flame can cause a composite pole to smolder with a limited amount of flame when applied directly to the surface of the pole; however, as soon as the flame is removed, the composite material ceases to smolder or produce flame. This makes composite poles extremely attractive for deployment in steep mountain canyons and ravines where wild fires may roll through an area in 20 to 30 minutes. In these locations, use of selected fire-retardant coatings can enable the poles to withstand up to two brush fires. More importantly, after exposure to fast-moving brush fires, the poles generally do not require replacement and will continue to support the lines and equipment with no loss of strength.

The resilience of composites is one of their more remarkable features. Composites allow strength parameters to be accurately "dialed in" during manufacturing to meet the job specification. This saves time and money and eliminates waste. The service life of a composite pole is conservatively rated at approximately 70 years on average. In addition, composite poles are extremely lightweight and strong, and do not lose their strength over their lifetime.

Some composite poles, such as those from Resin Systems Inc. (Calgary, Alberta, Canada), are manufactured and shipped as modular sections (typically, 15-ft [4.5-m] lengths are nested one inside the other), which reduces transportation and installation costs. For example, two men can easily lift an individual 15-ft module of a pole and maneuver it into position without any heavy equipment. This ease of handling also applies to the crossarms, which are typically very heavy work for linemen.

EMBRACING CHANGE

Obviously, any new product or technology offered to the electric power industry needs to be thoroughly tested before it can be deployed to a live grid. To better evaluate new technologies that might enhance grid reliability and possibly lower service costs, SCE created a new section on the grid in the Inland Empire Region known as the "Circuit of the Future."

SCE worked closely with a number of composite-pole manufacturers, including Powertrusion International (Tucson, Arizona, U.S.) and Resin Systems, to help them design and manufacture a series of composite poles that meet SCE's needs in terms of strength, durability, serviceability and service life.

Each composite-pole company has its own patented method of production, which means each type of pole has a unique set of characteristics. For instance, the Powertrusion pole is a nontapered (i.e., it has a constant diameter) pultruded pole, while the Resin Systems pole is manufactured by winding E-Glass and polyurethane resin along with other proprietary materials onto a spe-

Even fully assembled, the composite pole is substantially lighter than wood or other materials and easily transported by a helicopter.

cially designed mandrel, a process known in the industry as filament winding. The Shakespeare (Newberry, South Carolina, U.S.) composite poles also are manufactured using the filament-winding process. The chemical composition of the resins, types and amounts of E-Glass, winding patterns and tensions vary significantly from one manufacturer to another, and these different factors are proprietary to the respective manufacturers.

HARDWARE MODIFICATIONS

Attaching equipment to hollow composite poles, rather than solid wood poles, requires different hardware and methods; however, different does not necessarily mean more difficult. For instance, rather than drilling holes and then bolting brackets directly into wood, a composite pole requires that a hole be drilled completely through the pole, so the drilled hole extends completely through both walls of the hollow pole. The equipment brackets are attached by long through-bolts, nuts and plate washers (flat washers for pultruded poles and curved ones for round filament-wound poles) on both sides to evenly disperse the clamping force.

Several specialized pieces of pole line hardware were specifically developed as substitutes for the traditional pole line hardware originally designed for use with solid wood poles and not for the new generation of hollow composite poles. SCE has developed a complete accessory manual to assist field personnel in finding the appropriate substitute hardware for use with composite-pole work orders

A lineman's job is strenuous. One of the tasks composites have made less strenuous, if not easier, is crossarm replacement. Traditional wood crossarms are heavy and can be unwieldy when being handled by a lineman working at the top of a pole. The lineman's and groundman's potential for injuries is reduced and productivity is likely to be substantially increased when composite crossarms are substituted for wood crossarms. The weight of a composite arm is significantly lighter, thus making it easier to handle than a wood arm.

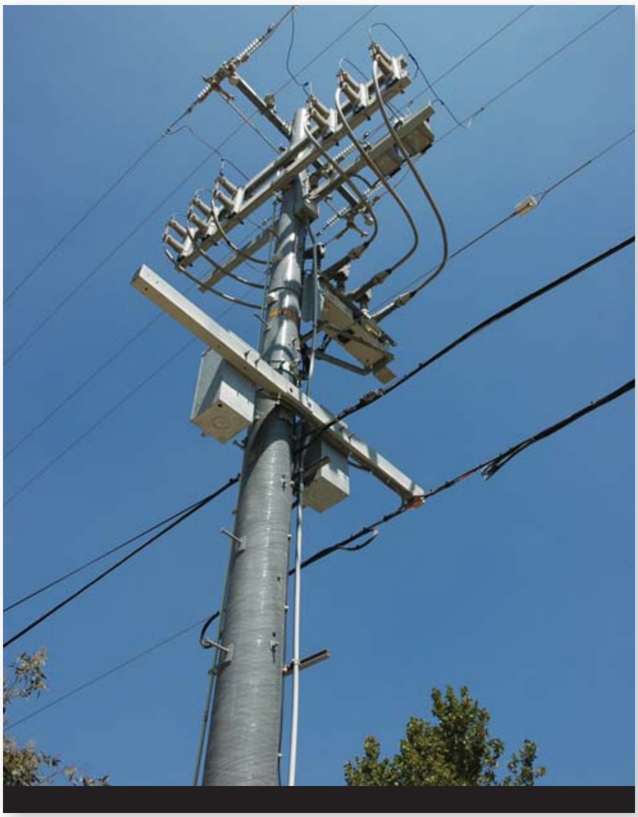
MODULAR VERSATILITY

One of the more-intriguing aspects of using a hollow composite pole is the flexibility it allows during pole erection. This is particularly true when erecting poles along constricted rear property lines that require poles to be set by hand or with heavy cranes. Composite poles are available in two forms: one form being single-length poles such as 40 ft (12.2 m), 45 ft (13.7 m) and 50 ft (15.2 m), and the second form being modular poles that are stacked together to the desired height. The second form makes it possible for the pole to be erected by a line crew using hand tools and equipment, because the line crew is working with a series of shorter and lighter modules rather than a single heavier-length pole.

Modular poles are inherently more versatile than single-length wood or composite poles. For instance, Resin Systems builds several different length and strength pole modules, which can be assembled in several different combinations to create a pole of a desired length and class. The ability to create a pole of a specific length and class in this manner is an advantage for this pole configuration. The same method of assembly can be performed by a utility at its own facility or in the field.

Modular poles are shipped nested one inside the other. When unloaded, taken apart and assembled, the modules will yield a pole of specific length and class. Modular poles also give utilities greater flexibility in responding to custom situations. For example, an emergency situation might require a pole of a specific length and class in order to restore service to an area. However, there may not be any poles available in inventory to meet the specific length and class requirements for the job. Rather than delay the job or erect a costly temporary work-around that would require removal at some point, it is more efficient and cost effective to separate some of the existing pole bundles and choose the specific modules needed to assemble a pole that meets the job requirements.

In mountainous areas, distribution poles are frequently damaged during heavy annual snow storms. Snow-laden trees may fall across distribution lines, which can and often does result in a pole breaking off 5 ft to 8 ft (1.5 m to 2.4 m) above the ground line. Many of these



This composite-pole top on the "Circuit of the Future" has a vacuum recloser and bypass switches. (Photo by Kevin Coates.)

pole breaks occur in remote locations, which means that most of the repair or replacement work has to be performed by hand. To make matters worse, these poles are often set in very rocky soil, making it difficult and time consuming to exhume the butt.

One timely and cost-effective method SCE has used to make a repair in this type of terrain involves trimming the damaged pole down to a point where there is between 6 ft (1.8 m) to 8 ft of solid stub remaining. Then, an equivalent length and class of composite modular pole is set over the wood stub and secured with through-bolts at approximately 4 ft (1.2 m) above grade. A closed-cell foam is then injected to fill any void between the wood stub and the composite-pole module.

COST/BENEFIT ANALYSIS

To appreciate the real value of composite poles, which typically can range from one-and-a-half to twice the price of a comparable wood pole, utilities need to look past the first cost, and focus on the life-cycle costs associated with each type of pole. Such comparisons will help a utility identify areas where it could realize significant savings.

Over the life of a composite pole, rated conservatively at a minimum of 70 years, at least two wood poles would need to be purchased — an obvious value proposition on first-cost alone, since the cost of one installation would be required instead of two. Also, because the evidence to date indicates that composite poles are not seriously affected by such things as insect infestations, fungi, outer-shell cracking or loss of heartwood as a result of decay, it appears that composite poles may not require periodic intrusive inspections or internal chemical treatments, which can be very costly over the life of a wood pole. This is especially significant when one considers that a utility like SCE has approximately 1.5 million poles in service. TDW

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