RELIAPOLE
SOLUTIONS INC

MYTH VS. REALITY
IN SELECTING DIRECT EMBEDDED STEEL POLES FOR SPORTS LIGHTING INSTALLATIONS

Wesley J. Oliphant, PE, F. ASCE
President, ReliaPOLE Solutions, Inc.

ReliaPOLE Solutions, Inc.
32624 Decker Prairie Road
Magnolia, TX 77355
www.reliapole.com

INTRODUCTION

It cannot be known for sure when the first use of a pole to support something in the air was installed. But know for certain it was a long, long time ago. Today, poles manufactured from a variety of materials and configurations, are all around us. Everywhere we look, poles are an important part of our societal infrastructure. Poles support our very critical electrical power transmission and distribution delivery system. Poles support our communications systems, both land lines and wireless. Poles support our traffic signal & monitoring systems to make our highway and roadway network safer. Poles support lighting for our highways, shopping centers, sports and recreational facilities. The list goes on and on.

Without a doubt, the most prevalent non-wood material used today in the design and construction of pole structures is steel. Why? Steel Poles are aesthetically attractive, lightweight, durable, cost effective, and readily available. From a design engineering perspective, steel poles have reliable and predictable strength, and behavior. And, with appropriate corrosion protection, steel poles will provide a lifetime of service in even the harshest of environmental exposures.

Other materials used for the design and manufacture of poles are prestressed concrete, and fiberglass reinforced polymers (FRP), sometimes referred to as fiberglass composite poles. Each of these materials has its own unique characteristics, and both positive and negative performance and constructability differences compared to steel poles. These materials will also provide excellent serviceability if appropriately designed, manufactured, and maintained.

THE SPORTS LIGHTING APPLICATION

In the United States, most sports lighting applications (Baseball field, Football field, Soccer field, Tennis courts, etc.) utilize steel poles. Concrete poles and FRP poles are also now being used due to an increasing availability of poles made of these materials. Some companies even offer poles that are a hybrid and utilize multiple materials (i.e. steel and concrete). Which type is best? The quick answer is, it depends. If properly engineered, manufactured, installed, and maintained, all of these different "poles" can perform in a suitable manner. Each type of pole has strengths and limitations that must be considered for sports lighting applications. Concrete poles can be initially less expensive, but due to their weight can be more difficult and perhaps more expensive to install. Fiberglass poles typically are the most expensive alternative for sports lighting applications, and, due to a lower modulus of elasticity require a close look at deflection requirements in the design stage. Also, concrete poles, hybrid poles with concrete bases, and fiberglass composite poles have certain upper limit strength limitations. Steel poles are relatively lightweight, and have unlimited design range for strength. The knock on steel is the "potential" for corrosion. The reality is all poles produced today, no matter the type, will long outlive their useful economic life if they are properly designed and manufactured. With that in mind, which pole is best should be a strength decision, a cost decision, an aesthetics decision, a constructability decision, etc. It should not be a serviceability, or durability issue.

THE PERPETUATION OF THE CORROSION MYTH

Unfortunately, a number of myths regarding the use of steel poles, particularly direct embedded steel poles, have been perpetuated in order to promote other types of pole materials.

MYTH – "Direct embedded steel poles will corrode."

While all materials will deteriorate over time, the reality of the issue is that very effective barrier protection systems have been developed and are being utilized by the steel pole industry. To suggest that direct embedded steel poles should not be utilized due to fear of below grade corrosion, is to eliminate a very cost effective and durable alternative to other steel pole foundation systems (typically anchor based steel poles, or hybrid (concrete base, steel top) systems, or, other pole material choices.

All materials will deteriorate if unprotected against the elements that cause deterioration of that type material. None of the common materials used to make poles is immune from deterioration. Steel must be protected from the process of oxidation. Concrete must be protected from both chemical attack (i.e. extreme PH, chloride and sulfate content in soils, as well as alkali silica reaction when concrete is made with certain reactive aggregate material) as well as freeze thaw cycles. Also, the reinforcing steel in prestressed concrete poles must be protected as any other steel. FRP materials must be protected from Ultraviolet exposure and they are more prone to mechanical damage (lawnmowers, etc.). All materials must be protected in some fashion from both the man made and natural causes of normal deterioration. Let me repeat that. ALL MATERIALS must be protected in some fashion from deterioration. Direct embedded steel poles are no exception.

CORROSION PROTECTION SYSTEMS FOR STEEL POLES

Specifically let's discuss the below grade protection systems for steel poles. There have been tremendous advancements over the last 10 years or so in the understanding of the below grade corrosion process and how to control it.

The corrosion of steel takes place because small areas on the surface of the steel can have small differences in electrical potential. When this happens, one area becomes anodic and the other area cathodic. In the presence of an electrolyte (moisture), the anodes become connected to the cathodes, a corrosion cell is created, and a small electric current begins to flow. The ions produced by the iron content of steel can begin to form loose flaky iron oxide, typically known as rust. Some mechanism must be introduced to interfere with this corrosion cell in order to protect steel from corrosion. This is done by either blocking the electrolyte from creating the cell (barrier protection) or by introducing a sacrificial material (an anode) to keep the steel itself from becoming the anode.

By covering the steel with a zinc surface through the hot dipped galvanizing process, the zinc will protect cathodically both the internal and exterior surfaces of the steel pole. This is a well proven technology and widely used to protect steel from very harsh environmental conditions. More recently, barrier coatings have been added as well to the arsenal of corrosion protection technology. These high-tech barrier coatings are not to be confused with traditional "paint", although the concept is similar. By adding a layer of barrier protection, the formation of potential corrosion cells is interrupted. The combination of a zinc coating alloyed to the steel through the galvanizing process plus the addition of a barrier protection system will provide a synergistic effect. The protective value of the combined system is much greater than the protective value of the zinc and barrier coating systems measured separately. On one hand, the alloying of the zinc to the steel during galvanizing will protect the steel, and on the other hand, the barrier coating will slow the sacrificial cathodic reaction of the zinc. It is a proven effective dual protection system for the protection of steel poles. When a concrete backfill material is added, even further barrier protection is realized.

Also important in controlling corrosion in direct embedded steel poles is to look at the soils. In several of the western states (Arizona, California, Nevada) the soils are known to have a high alkali or sulfate content that can react with cement in concrete and cause rapid deterioration of concrete? Because of this, a different kind of cement is typically used in that part of the country (Type 5 cement – sulfate resistant) that resists this reaction. With direct buried steel it is the same issue. In the above example, it is specifying a specific type of cement. With steel poles, it is designing a finish which as discussed above can include a variety of elements including a barrier protection system.

Our industry (the pole industry) has found that new generation organic polyurethane barrier coating systems work quite nicely with direct embedded steel poles. The barrier coatings currently used in almost all steel pole products furnished today are either aromatic or aliphatic polyurethane coatings similar to those used in the underground storage tank and pipeline industries. These polyurethane coatings are very durable, very tough, polymer materials. To be sure, they have to be applied properly and with an appropriate thickness, but when done so, they perform well. The electrical utility industry, utilizes in excess of $1 billion worth of steel poles annually. A very high percentage of these poles are direct embedded steel poles.

RECOMMENDED PRACTICES FOR BELOW GRADE PROTECTION OF STEEL POLES

Direct embedded steel poles for most sports lighting installations should utilize the following triple coverage corrosion protection system:

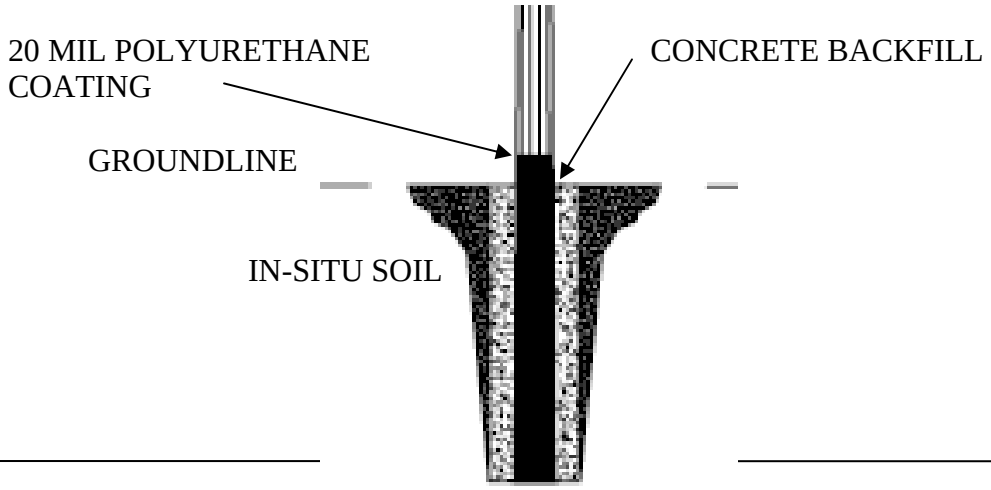
- The steel pole should be specified with a hot dipped galvanized finish per ASTM A123 (with this process the zinc from the galvanizing electrochemically protects the above ground steel as well as the below ground steel on both interior and exterior surfaces)

- A nominal 20 mils of either an aliphatic or aromatic polyurethane barrier protection coating specifically formulated for the use on steel poles should be applied to the full below grade length of the pole. The bearing plate is generally not coated for purposes of providing enhanced grounding.

- The annular void between the pole and the wall of the augured hole in the ground should be filled with concrete.

The above recommended practice will provide multiple levels of corrosion protection for the steel pole. When all three protection mechanisms (2-4 mils of zinc on the pole, the nominal 20 mils of polyurethane coating, and the 4-12 inches of concrete backfill) are combined, excellent corrosion protection resistance is provided for the external surfaces of the steel. For the internal surfaces, the zinc alone will generally protect very well. But if high water tables in highly corrosive soil environments are to be expected, it is generally recommended to consider applying the polyurethane barrier coating on the interior as well. But this kind of "double whammy" (high water table combined with highly corrosive soil chemistry) is not very common and therefore the expense of the extra interior barrier coating, or consideration of alternative foundation systems is generally not necessary. But where it is known to specifically occur, it should be considered.

HOT DIPPED GALVANIZED STEEL POLE



SUMMARY

A variety of pole materials (steel, concrete, fiberglass composite) is available for sports lighting applications. All have their own strengths and weaknesses as an engineered structural system. The decision on which material to use should be more a decision on strength, cost, constructability, and aesthetics, not on the perpetuated myth of corrosion of steel poles. Problematic below grade corrosion of these type installations is just a myth. Hundreds of thousands of direct embedded steel poles have been installed by the electrical utility industry, and corrosion protection systems have been studied and developed that provide excellent long-term protection and serviceability for these poles. For sure the poles have to be manufactured properly and the finish and barrier coatings properly applied. For sports lighting applications, a triplex protection system of: 1) hot dipped galvanizing for cathodic protection of the steel; 2) a 20 mil barrier of polyurethane coating developed specifically for steel poles applied over the full embedment length; and 3) a concrete backfill, will provide a very cost effective and durable corrosion protection system for steel poles in most all soil conditions.

About the Author:

Wesley J. Oliphant, PE, F.ASCE has more than 32 years experience in the design, and manufacture of most all available types of non-wood poles – Steel, Concrete, and FRP (Fiberglass Composite). He is currently President and CEO of ReliaPOLE Solutions, Inc., located in Magnolia, Texas. Mr. Oliphant is a Fellow of the American Society of Civil Engineers and is a Charter Member of the Structural Engineering Institute. He is a registered Professional Engineer in the State of Texas. He has been active in a number of industry organizations related to developing of standards for the design and use of steel, concrete, and fiberglass composite poles. He has been named as either inventor, or co-inventor on five patents for innovative developments related to pole structures. He has presented numerous technical papers related to the design and use of steel, concrete, and fiberglass poles.