PRIMER

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Become familiar with general components and conditions that might alert you that trouble is on the horizon with your light pole inventory.

Maintaining Your Light Pole Inventory for Longer Service Life

Light poles are simple structures that illuminate the world around us. Made up of rudimentary components, maintaining them can be a simple process. However, it is essential to answer the following questions: What are the primary components of light pole construction and what should we be on the lookout for to avoid failures? In this WJE Primer, we will explore the answers to those key questions.

Light poles are nearly universal structures that line our streetways, sidewalks, parking lots, athletic fields, and more. While the luminaires that illuminate paths for pedestrian or vehicular traffic are the common focus of maintenance efforts, maintenance of the poles and anchorage systems supporting them is often overlooked. Only when failures occur are the poles recognized as valuable and critical assets to be reviewed and maintained. Deterioration that can progress in the absence of regular and thorough maintenance can present risk of damage to property and/or injury to a passersby.

The key to understanding the condition of your light pole inventory is to become familiar with the general components and conditions to look for that might alert you that trouble is on the horizon. Here we explore the six basic components of typical light pole construction, including the *Foundation*, *Anchor Bolts*, *Base Plate*, *Welds* attaching the pole to the base plate, *Pole*, and the supported *Luminaire*. For each element, we provide a brief description, common failure mechanisms, and some advice with regard to when maintenance, mitigation, or replacement might be warranted. Our focus is primarily on common parking lot poles less than 50-feet tall.

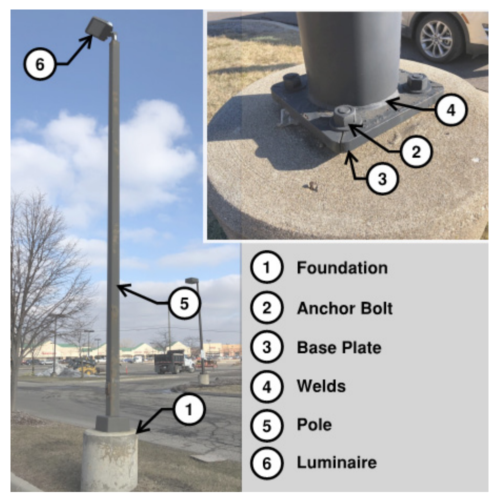

Figure 1. The six basic components of typical light pole construction.

Foundation

Light pole foundations are typically composed of cast-in-place reinforced concrete piers with protruding steel anchor bolts. Common issues with concrete foundations include cracks and spalls (usually from expansive corrosion of embedded steel) and leaning foundations. While not always of structural significance, when cracks align with an embedded anchor bolt (Figure 2), the structural capacity of the assembly (i.e., ability to resist wind loads) could be compromised and warrant further action.

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Light Pole Service Life (CONTINUED)

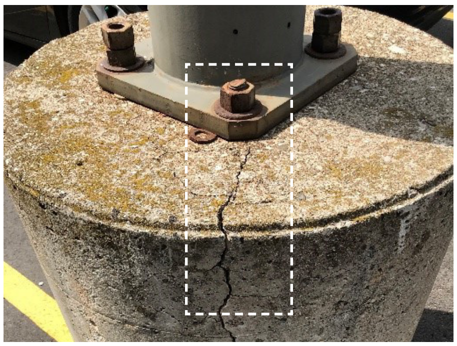

Figure 2. Foundation crack aligned with embedded anchor.

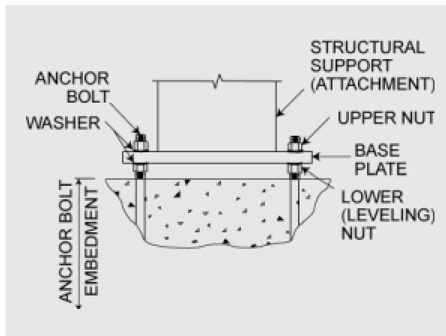

Figure 3. Typical double-nut connection (Figure C5.16-1).*

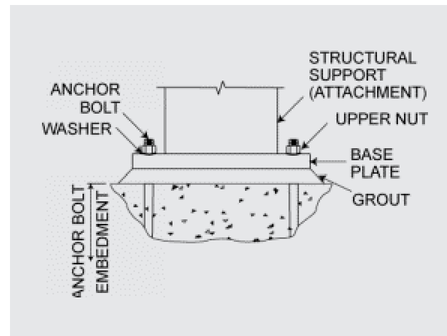

Figure 4. Typical single-nut connection (Figure C5.16-2).*

* Excerpt from: *AASHTO 2017 Interim Revisions to the LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*

Reminder: Periodically inspect for foundation distress.

Anchor Bolts

Pole structures are commonly anchored to the concrete foundation with threaded steel rods (anchor bolts). Embedded during foundation concrete placement, the anchor bolts extend above the foundation surface and are aligned with holes in the pole base plate, which is secured with nuts. Specific connection styles can vary, including leveling nuts (i.e., double-nut) (Figure 3) or grout beneath the base plate (i.e., single top nut) (Figure 4). Base plates seated on a full bed of grout restrict drainage and permit water retention within the hollow pole. Retained moisture can accelerate corrosion of the pole, base plate, and anchoring elements, ultimately leading to premature failure.

Similarly, anchor bolt and base plate covers, while serving an aesthetic purpose, can trap debris and moisture which can lead to corrosion of the pole (described further below), base plate, and anchor bolts (Figure 5 and Figure 6).

Tight installation of the upper nuts is critical for long-term performance. If nuts are not properly tightened initially, or if they loosen over time, the resulting gap will permit the pole to rock on its foundation under wind loading. This type of repetitive rocking can induce impact loads on all components, increasing the risk of developing cracks.

Reminder:

- Given design or selection input, eliminate anchor bolt covers and opt for leveling nuts below base plates to allow for ventilation and drainage from the pole. Also consider use of wirecloth screening around the pole base to avoid attracting nesting insects.
- Check and tighten nuts on a regular basis to prevent rocking and related distress.
- Routinely remove debris from inside the pole and under the base plate to reduce the risk of corrosion. Access to the pole interior via the hand hole (i.e., opening in pole to allow service of electrical elements) may be necessary.

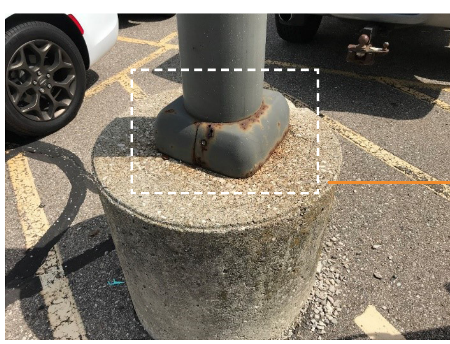

Figure 5. Base plate cover in place.

Figure 6. Same pole from Figure 5, with base plate cover removed, revealing corrosion and debris.

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Light Pole Service Life (CONTINUED)

Base Plate

A base plate serves as the interface between the steel structure and the foundation and is designed to transfer forces into the anchor bolts and foundation. The base plates must resist wind from tipping over the pole assembly by pulling up on one or more nutted anchor bolts. If holes in the base plate are oversized relative to the diameter of the anchor bolt and nut (Figure 7), a pull-through failure may occur which would destabilize the light pole. Washers may be introduced as part of the design or to accommodate over-sized holes, however the washers require proper design in order to adequately transfer loads without deformation (Figure 8).

Reminder: Visually assess base plate for proper hole size, nut tightness, and bearing.

Welds

The pole-to-base plate connection traditionally features a socket-type base plate connection (Figure 9), where the pole is nested within a hole in the base plate and the fillet welds around the pole perimeter

Figure 7. Oversized bolt hole.

at both the top and bottom of the base plate transfer loads from the pole and luminaire to the base plate. Weld cracks are most often the result of cyclical wind loading of light poles. Based on WJE's experience, square profile poles with fillet welds made using a manual process are most prone to weld cracking (Figure 10), with the risk increasing as pole height increases. Square poles experience stress concentrations at the corners, whereas round poles allow for a more even distribution of stress. While cracks can be readily visible, specialized nondestructive techniques, such as a magnetic particle testing, can aide in identifying early-age cracking.

Figure 8. Deformed washer.

Reminder:

- Given design or selection input, avoid use of square poles, especially greater than approximately 30 feet in height. Consider round, tapered poles with pole-to-base plate welds performed by an automated process.
- Periodic inspections of welds should be performed by qualified personnel.

Pole

The typical parking lot pole that is the subject of this article is made of mild steel and, as such, is subject to corrosion and associated section loss, which often manifests at the base (Figure 11). While

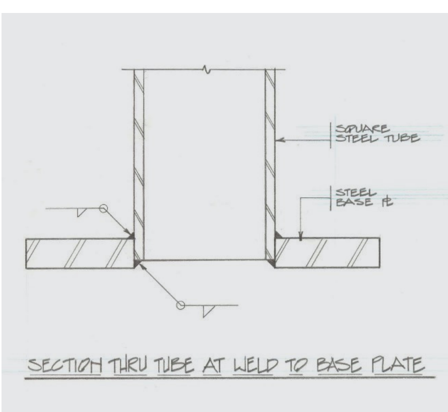

Figure 9. Socket-type base plate connection.

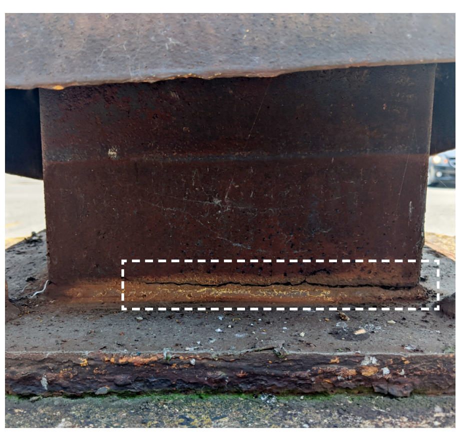

Figure 10. Crack at welded connection to base plate of square pole.

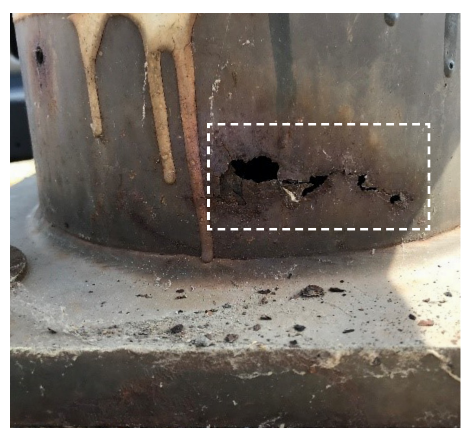

Figure 11. View of exterior base of pole with through section loss due to corrosion.

Figure 12. Exterior view of subject pole.

Figure 13. Interior view of subject pole.

Figure 14. Holes punctured in subject pole by light tapping with hammer.

steel poles are typically produced with an exterior paint coating to inhibit corrosion, the exterior coating can degrade, flake, and peel over time, leaving the surface susceptible to exterior surface corrosion.

As noted above, water and debris that may collect inside a pole at its base often enters via the open space below the base plate, through the hand hole in the pole, or other pole openings. This accumulation can cause or accelerate corrosion on the interior surface of the pole. Even when severe, interior corrosion may be visually undetectable from the exterior. A pole can appear to be in good condition from the exterior yet may have significant section loss at the base of the pole from inside-out corrosion (Figure 12, Figure 13, and Figure 14). Ultrasonic thickness gauges can be used from the exterior to measure the remaining pole wall thickness. By comparing the measured remaining thicknesses to the intended original thickness of the pole wall, or a measured thickness of the pole in an area where there is no corrosion, the extent of section loss can be determined and used to evaluate remaining structural capacity. Collecting various measurements over time can also help determine the rate of section loss due to corrosion, which can inform when repairs or replacement might be warranted. Considering that repair work to the interior of the pole is difficult due to limited access, replacement is often the most viable remedial action. The simplest way to slow interior corrosion, and thus extend the service life of the pole, is to keep the pole interior clean and promote ventilation/drying.

Galvanized steel poles typically resist corrosion significantly better than painted steel poles because the galvanizing is typically more durable than paint and—as an inherent result of the galvanizing process—is also present on and protects the interior surface of the pole.

Reminder:

- Regularly maintain corrosion-inhibiting coatings on exterior surfaces of steel poles and base plates.
- If corrosion or section loss is suspected, retain a qualified professional to obtain thickness measurements and perform an analysis to determine minimum thickness that would provide adequate structural performance.
- When replacing light poles, consider galvanized poles for increased corrosion resistance.

Luminaire

The luminaire atop the pole is typically a proprietary component with endless permutations of shapes, sizes, and other physical and performance characteristics (Figure 15). While not often the source of pole failure, when luminaire replacement is considered, it is important to understand that each luminaire type bears an effective projected area (EPA) that characterizes the luminaire's contribution of wind load into the pole. When it is time to replace a luminaire, an increase in EPA may warrant a structural analysis and field assessment to verify that the original design and current condition of the pole can adequately resist the increased wind load. Even if the EPA of the new luminaire is less than the replaced luminaire's EPA, evaluating the condition of poles, welds, base plates, and foundation elements intended to remain in service is prudent to avoid investment in luminaire replacement only to experience failure of supporting elements shortly thereafter.

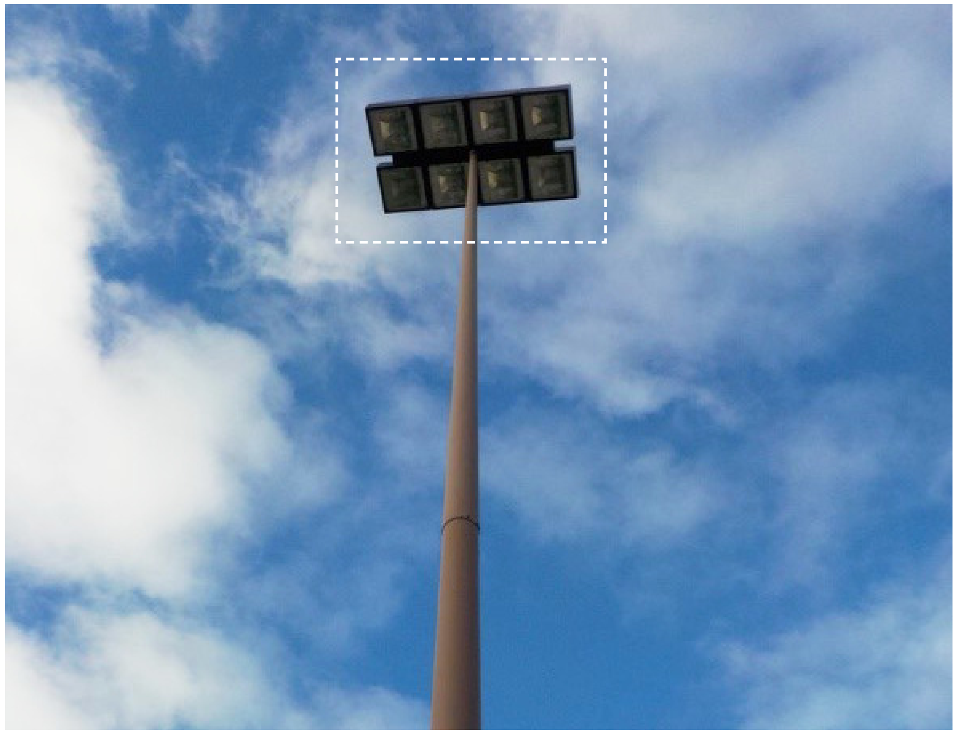

Figure 15. Representative light pole luminaire.

Reminder: Consult a structural engineer for evaluation of the entire pole assembly when considering luminaire replacement, particularly if EPA is going to increase.

Appendages

Though not an inherent component of light pole construction, it is often common to see different appendages such as banners, security cameras, or other signage attached to a pole. While seemingly harmless, appendages can inadvertently increase the wind loads on the pole. Therefore, appendages should not be added to a pole unless the pole was designed to accommodate the additional wind area or an analysis indicates the pole has sufficient capacity to receive such an appendage.

Reminder: Consult a structural engineer prior to installation of an appendage.

Summary

While often not a focus of property management or maintenance, light poles are among the most prevalent structural systems within the world around us. Understanding basic principles of light pole construction and implementing routine inspections by qualified personnel will aid in early identification of defects that, when addressed properly, can prolong service life and prevent failures.

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