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Case Study: Communication Tower Inspection

By

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Subject

Inspection of a 300 foot communications tower located in Minnesota. The tower was inspected prior to purchase by a new owner. The tower inspection was not a full inspection and only included conditions readily observed from the ground to identify structural and electrical defects that could have detrimental effects on the operation of the radio stations using the tower. The relative engineering standards and specifications for communications towers and equipment are referenced.

Inspection Findings

Figure 1 – Tower and Communications House

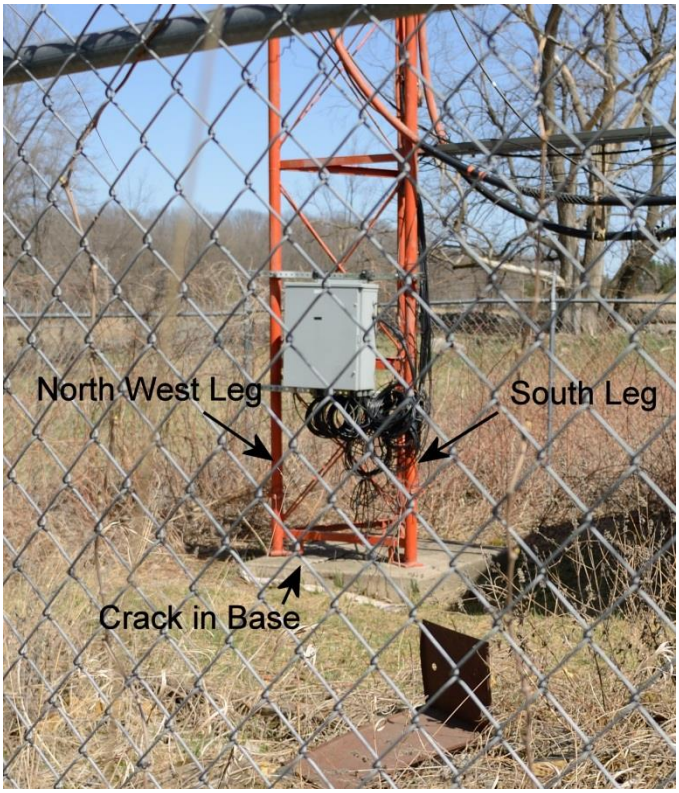

Figure 2 – Tower Base

Figure 1 shows the tower and site. The view shown in this photo was from the east.

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Figure 2 shows the tower base as seen from the southwest. The two visible legs are labeled on the photo to aid in further discussion.

Figure 3 – Anchor Point, South Tower Leg

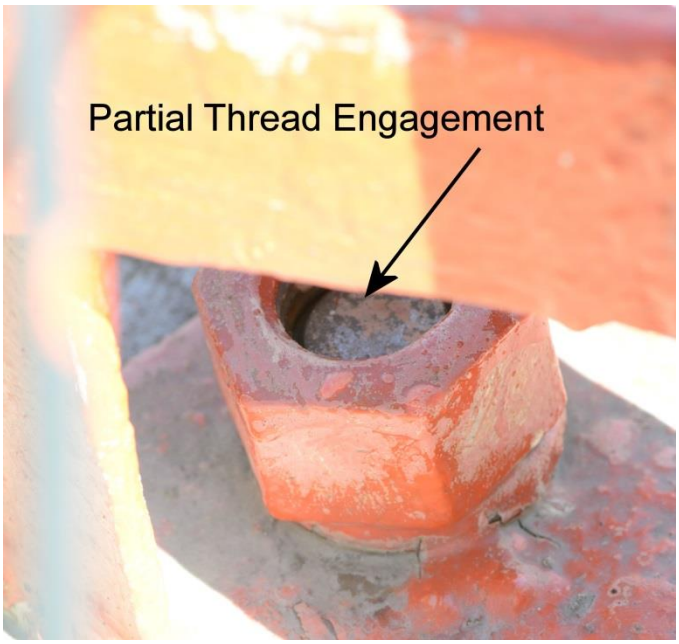

Figure 4 – Partial Thread Engagement, Anchor Point, South Tower Leg

American National Standard for Specification for Structural Steel Buildings, page 118, Section J3.1. states that, "Bolts are permitted to be installed to the snug-tight condition when used in: (a) bearing-type connections and (b) tension or combined shear and tension applications, for Group A bolts only, where loosening or fatigue due to vibration or load fluctuations are not design considerations." The loading at the guyed tower base should only be compression; therefore, a snug-tight connection is acceptable. The snug-tight condition is defined as the tightness required to bring the connected plies into firm contact. The connection shown in Figure 3 does not meet this requirement. There is a gap between the plate and concrete, and the lock washer has not been compressed. Figure 4 shows incomplete engagement of the nut and anchor bolt. This is not acceptable by any standard.

The nut is not fully engaged with the anchor bolt. Figure 5 shows the connection at the tower base at the north tower leg. There is a plate under the tower leg filling the gap. The nut is not fully engaged and there was no lock washer at this location.

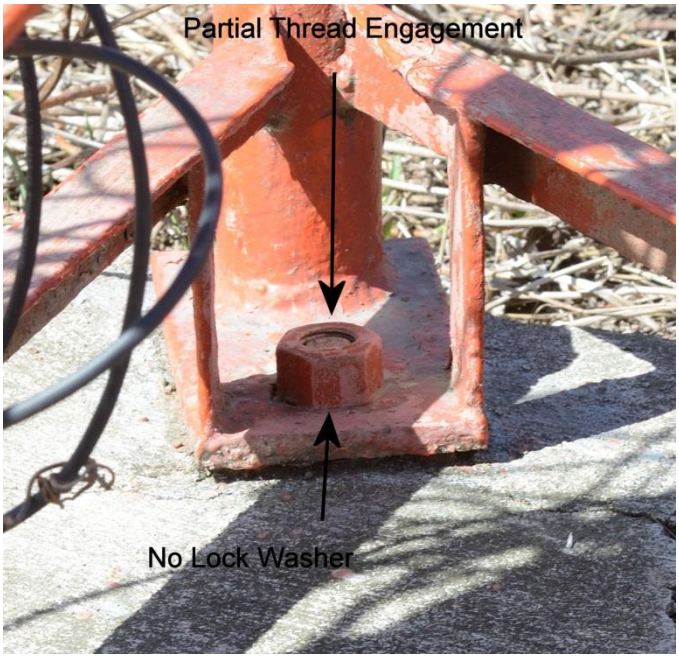

Figure 5 – Tower Base Connection, North Tower Leg


Figure 6 – East Tower Leg Connection

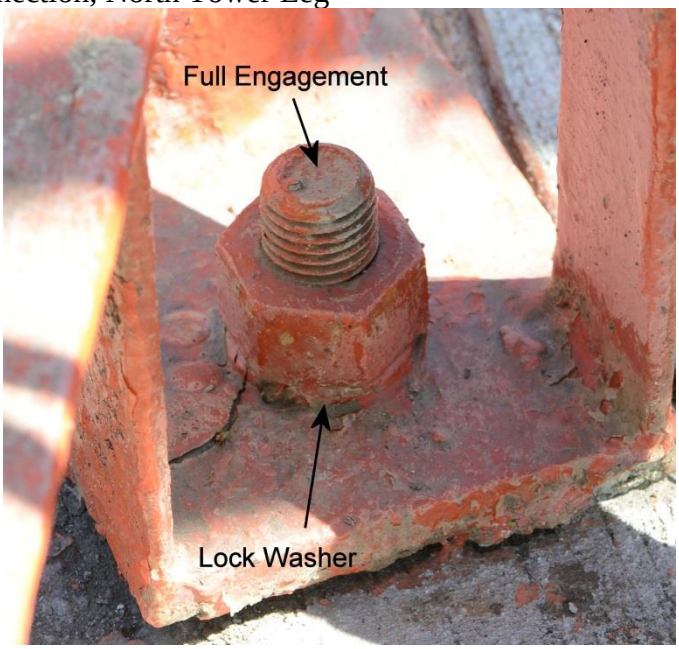

Figure 7 East Tower Leg Connection

The connection between the concrete base and the east tower leg looks to be very good when viewed from the south, Figure 6. The view from the west, Figure 7, is much different. The east tower leg is only contacting the concrete along the south side of the bottom plate. This connection is also not acceptable.

Figure 8 shows the cracked concrete base associated with the north tower leg. The cracking could be from the tower having been forced to the south, resulting in tensile force in the top layer of concrete. It may also be from settling of the north side of the concrete base, meaning that the base and footing are not deep enough to be below frost line. The cracking could have been the result of a lightning strike, because of a

poor grounding system. The concrete base supporting the tower will likely need to be replaced. The nut and anchor bolt are not fully engaged, and the plate is not flat on the concrete.

Figure 8 – Cracked Concrete Base North Leg

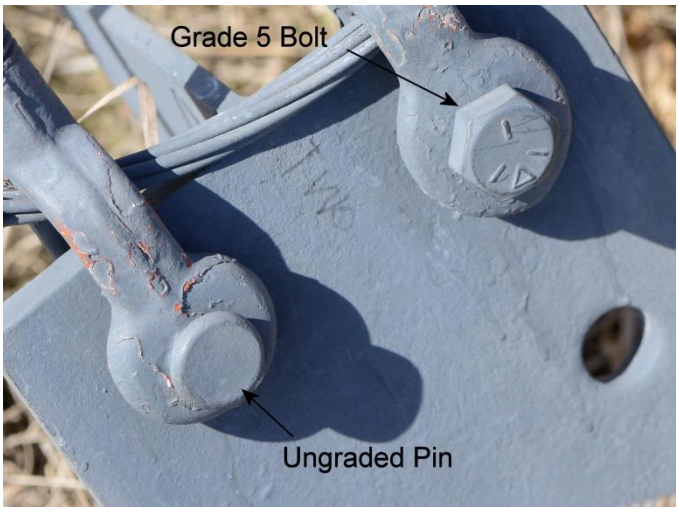

Figure 9 – East Guy Wire Anchor #1

Figure 10 – East Guy Wire Anchor #2

Figures 9 and 10 show the two guy wire anchors east of the tower. It is very likely that the conditions at these two anchors are typical of the other four anchors. Figure 9 shows one clevis held in place with a Grade 5 bolt, and the other clevis held in place with an ungraded pin. Figure 10 shows two of the clevises held in place with pins, and the third one with a Grade 5 bolt. The hole in the anchor where the Grade 5

bolt is used was elongated. It appears that the original clevis pins may have been Grade 5. Any repairs need to be done using Grade 5, or ASTM A325 fasteners.

Figure 11 – Tower Ground Connection

Mil-STD-124B Grounding, Bonding and Shielding for…Communication… and many industrial standards are available guidelines for lightning protection. These guidelines far exceed the requirements of the Electrical Code. The ground connection shown in Figure 11 meets the Electrical Code, but does not come close to the standards used by the communications industry. The following is a list of some of the issues involved in grounding of communication equipment and towers.

Issue one is the depth of the ground rods. For commercial applications, the minimum depth for the top of the ground rod is two feet below the ground surface. It is also required that the ground rods be deep enough that they are always in wet soil and below frost line.

Issue two is that all ground connections must be bonded by silver soldering or welding.

Issue three is that all ground rods on the site must be connected together by a grounding ring.

Issue four is that the minimum copper wire size in the grounding system is 1/0. Some standards go with number 2 gage wire.

Issue five is that all metal on the site must be connected to the ground system, including fencing, and reinforcing bar in the tower base and communications building foundation and concrete flooring.

Issue six is that the tower guy wires need to be grounded. The guy wire grounding needs to be connected to the tower and building grounding system.

The resistance of the grounding system needs to be less than 5 ohms.

The ground wire at the tower location was number 6 copper, and the ground rods were flush with the surface of the ground. There was no evidence of bonding, and the guy wires were not grounded. A new grounding system is needed for this tower.

Opinion

It is my professional opinion to a responsible degree of scientific certainty based on the information available and discussed in this report that the communication tower needs repair and upgrading for reasons of safety and ongoing operations. The safety concerns are the concrete tower base, the tower base anchoring bolts and nuts, and the guy wire attachments. The grounding system needs upgrading to provide lightning protection for the broadcasting equipment and other communications equipment attached to the tower.