OUTDOOR POLES FOR SMALL CELL BACKHAUL

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OPERATOR CONCERNS ABOUT POLE SWAY FOR SMALL CELL BACKHAUL DEPLOYMENTS

Twist and sway requirements for towers and poles that support backhaul microwave hops are more stringent than for other RF equipment. This is especially true for deployments in frequency bands above 18 GHz where the antenna beamwidth is narrower. Standards such as the TIA-222-F set a minimum sway and twist that a structure should endure for a microwave installation. This creates concerns for operators interested in deploying microwave for small cell backhaul in structures like utility, lighting and traffic poles that are not designed to meet this standard. Although the use of a sturdy structure is always recommended a close look at lighting, traffic and utility poles suggests that under certain circumstances these structures can be an option for deploying microwave backhaul for small cell.

NOT ALL POLES ARE CREATED EQUAL

UTILITY POLES

Utility poles are primarily designed to support distribution lines and structures such as electric power, cable television, and fiber optic cables [1]. Poles that support distribution lines are built to meet the National Electric Safety Code (NESC) and the American National Standards Institute O.5.1 (ANSI O.5.1) standards. The NESC sets horizontal and vertical loading (that create sway) from various combinations of wind loading and ice on poles. Wood poles are governed by ANSI O.5.1 that classifies poles based on top circumference. Different tables are generated based on wood type and specify the stresses the pole can resist. These stresses are calculated by applying a horizontal tip load to simulate the horizontal forces transferred from the wires to the pole due to wind load. The common practice is not to design each pole based on standards but for experienced personnel to select the pole from manufacturers handbooks or in more complicated cases use specialized software to estimate the effect of wind and ice on the pole. Other materials also used for utility poles include steel and concrete.

LIGHT POLES

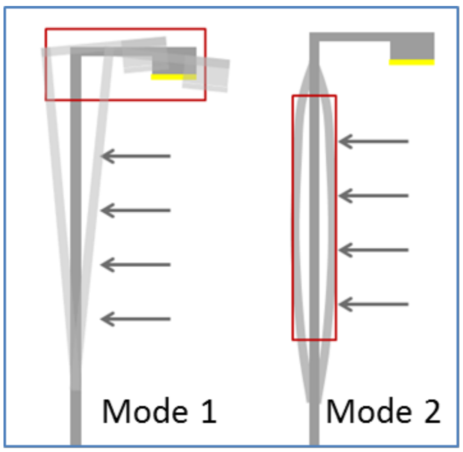
Light poles have a great variety of uses that include street, road or area lighting, and traffic signs. The standards that govern light poles include:

- AASHTO: American Association of State Highway and Transportation Officials. This standard specifies the general requirements, materials, design specifications, wind and weight loads under different environmental conditions.
- State Specific: Each state can decide what standard to use, but in most cases states use a specific version of the AASHTO.

- Commercial Criteria: In most cases if the pole is not going to be used by the department of transportation the manufacturer will use its own criteria instead of the AAHSTO standard. Commercial criteria are not as stringent as standard based criteria as in many cases cost is a definitive factor.

VIBRATIONS IN LIGHT POLES

As many pole deployments are based on commercial criteria instead of standards like ANSI or AAHSTO there is a greater possibility that light poles will vibrate under steady winds below 45 Mph. These vibrations not only can create sway for microwave deployments but also can lead to mechanical failure of the pole. Field data suggests that poles over 35 ft. that have a square cross section and Effective Projected Area EPA (projected area combined with the appropriate drag coefficient) of less than 2ft^2 are more likely to vibrate. The two main vibration types for light poles are shown in figure 1.



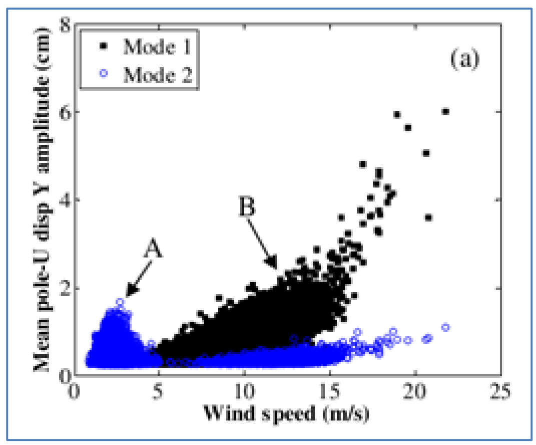


Figure 1 Vibration types

Figure 2 Vibration data for light pole

Both of these two vibration types will create sway that might affect the link performance. Figure 2 shows the measured vibration results for a typical light pole [2].

CASE FOR A TYPICAL LIGHT POLE

In order to evaluate the effect of sway and twist in possible backhaul deployments table 1 shows the results of the comparison of field measurements from a light pole [2] and maximum distance calculations for different microwave backhaul deployments in the bands of 18, 23, 70 and 80 GHz. The maximum distance was calculated for an availability of 99.99% for San Jose, CA and Miami, FL for different modulation options to show the effect of rain on the maximum distance. The comparison also takes into consideration the 10 dB loss angle from TIA-222-F. This angle can be used as a reference to gauge the maximum allowable sway and twist for a standard telecommunications structure against the sway experienced by a typical light pole. If it is assumed that the deployment scenario is from a building (no sway) to a pole with the measured data, it is clear that for all deployment cases the pole sway is below the allowable sway on a comparable standards compliant telecommunications tower.

		Frequency Band (GHz)	18	23	70/80
		Frequency Range (GHz)	17.700–19.700	21.2-23.6	71-80
		Antenna Gain (dBi)	33.5	30.5	43
		Antenna 3dB beamwidth (°)	2.2	3.3	1.2
		Antenna Size (m)	<0.3	<0.3	<0.3
		Max Radio Power (dbm)	51.5	34.5	42
		Channel Size (MHz)	80 MHz	50 MHz	1000 MHz
		Maximum FCC 3dB Beamwidth (°)	3.3	4.5	1.2
		Minimum FCC Antenna Gain (dBm)	33.5	30.5	43
		FCC Max EIRP (dBm)	85	65	85
		TIA-222-F Standard (10 dB loss)	1.7	2.6	0.9
		Target Availability (%)	99.99	99.99	99.99
Miami	Max Distance	QPSK Max Distance / Throughput	4.3 Mi / 90 Mbps	2.3 Mi / 74 Mbps	0.9 Mi / 360 Mbps
		16QAM Max Distance / Throughput	3.1 Mi / 182 Mbps	1.7 Mi / 148 Mbps	0.8 Mi / 720 Mbps
		64QAM Max Distance / Throughput	2.6 Mi / 269 Mbps	1.3 Mi / 233 Mbps	0.6 Mi / 980 Mbps
San Jose	Max Distance	QPSK Max Distance / Throughput	11 Mi / 90 Mbps	5.5 Mi / 74 Mbps	1.8 Mi / 360 Mbps
		16QAM Max Distance / Throughput	7.5 Mi / 182 Mbps	4 Mi / 148 Mbps	1.5 Mi / 720 Mbps
		64QAM Max Distance / Throughput	6 Mi / 269 Mbps	2.9 Mi / 233 Mbps	1.1 Mi / 980 Mbps
Sway Scenarios Reference Example	Building to Pole	Maximum wind speed: 11 MPH	0.1°	0.1°	0.1°
		Maximum wind speed: 22 MPH	0.22°	0.22°	0.22°
		Maximum wind speed: 34 MPH	0.26°	0.26°	0.26°
		Maximum wind speed: 45 MPH	0.64°	0.64°	0.64°

Table 1Sway and MW Small cell deployments

CONCLUSIONS

As utility poles (ANSI O.5.1 and NESC) and light poles designed under the AAHSTO guidelines usually have higher robustness that light poles designed using commercial criteria it can be inferred that the occurrence of vibrations due to steady winds less than 45 Mph, will be less likely in standards compliance poles. Even for poles designed using commercial criteria like the light pole shown as an example, vibrations that create sway can be in a range tolerable for link deployment. The installation of any structure on existing poles, including small cell and backhaul radios and antennas will necessarily change the weight and wind loading characteristics of the deployment pole. This will require a structural analysis to verify if the existing poll still meets the standards or the commercial criteria set by the pole manufacturer.

REFERENCES

[1] Special Research Topic Report on Current Practice in Utility Distribution Poles and Light Poles. Adam Crosby, 2011.

http://www.kornegayengineering.com/wp-content/uploads/2011/05/structural-utility-distribution-light-poles-whitepaper-acrosby.pdf

[2] Field Observations of wind-induced Mast-Arm Lighting Pole Vibration. Delong Zuo and Chris Letchford. Department of Civil and Environmental Engineering, Texas Tech University, M.S. 1023, Lubbock, TX 79409, USA, School of Engineering University of Tasmania, Private Bag 65, Hobart Tasmania 7001.