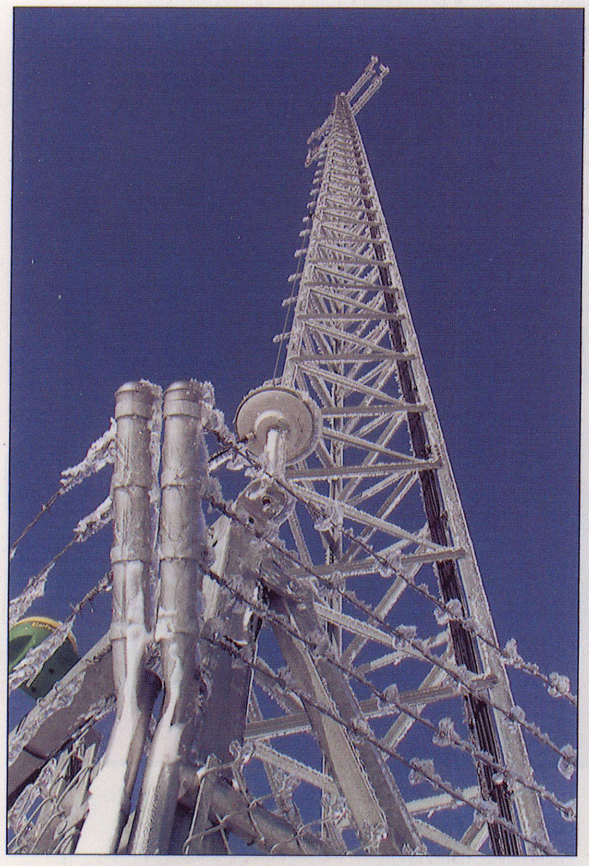
How Ice Load May Reduce Wind-load Stress

Ice may 'round' some flat steel members, improving structural aerodynamics. A tower may be less stressed *with* ice than without it.

by Dan Simmonds and Pete Jernigan, P.E.

Self-supporting towers are designed for the forces developed by the *dead load* and the *wind load*, with and without an *ice load*. The dead load force is the weight of the tower members and appurtenances, such as antennas and cables. The wind load is the force of wind blowing on the tower and appurtenances. The ice load force is that added weight caused by ice that forms and accumulates on the tower members and appurtenances.



A 100-foot tower at the Casselton, ND, beet-piler site (manufacturer, AN Wireless Tower).

These forces are used to develop two loading cases. Case 1 is the dead load of the tower with the appropriate wind load applied. Case 2 is the dead load of the tower, the weight of the formed, accumulated ice and the wind applied at a reduced load.

Ice will add weight and increase wind *area*. Nevertheless, the reduction in wind *speed* and the improvement in wind *flow* more than compensate for increases in weight and area. The result is a tower that is *less* stressed *with* ice than without.

In general, the forces developed in Case 2 impart less force on a tower. According to the governing U.S. antenna support structure standard (ANSI/TIA-222-G), the force developed by a 100-mph wind without ice will be reduced to a force developed by 75 mph with ice. This is a 44 percent reduction of pressure generated by wind. Further, ice may round some of the flat steel members, improving aerodynamics of the structure. This can be seen in the photo at the left. Notice that, when iced over, the sharp edges are dulled, thus improving wind flow.

In addition to the tower structure, attention must be given to the appurtenances. These might be antennas, tower-mounted transceivers, lighting hardware, feedlines or connections. For instance, a given length of unsupported standard coax or CAT5 line will be vulnerable to failure when encased in ice. UHF, Type N and similar connectors must be fully sealed to prevent moisture from entering the shield (outer conductor) of the line during the ice-melt stage. Impedance change is another unwanted effect of line saturation and stretch. This could require premature line replacement.

Tower alignment and stability are functions of the foundation and the soils supporting it. Consideration must be given to soils that are subject to frost effect or frost heave and soils that are subject to a high water table effect or settlement. We mention the settlement effect because there are areas where towers are subject to icing, yet the soils might not freeze simultaneously. Stability would be related to resistance to overturning, and alignment would be related to heave or settlement.

Local frost depth also must be considered when erecting a tower. The base of the tower foundation should be at or below the frost line. The pictured tower is located in eastern North Dakota, where the frost line is deeper than 7 feet. A tower foundation might shift if it is not at or below the frost line, thus altering tower alignment.

Similarly, a high local water table, creating an unstable soil condition, might contribute to settlement of the foundation, thus altering tower alignment. agl

Simmonds is the owner of AN Wireless Tower, Somerset, PA. His email address is *dan@anwireless.com.* Jernigan is president of Tower Engineering Professionals, Raleigh, NC. His email address is *pjernigan@tepgroup.net.*