Fact Sheet

ATMOSPHERIC ICING ON STRUCTURES

PROBLEM

Every winter, power lines and communication towers collapse in freezing rain storms. The glaze ice load on trees, wires, and structural members, combined with wind acting on the increased projected area, causes these failures. Repair costs after a severe storm can be hundreds of millions of dollars, and electrical outages may deprive residents and businesses of heat, water, and power for extended periods.

An ice storm in February 1994 that spread from Arkansas to Virginia took down thousands of miles of power lines, leaving some regions without power for four weeks, and caused millions of dollars in damage. In January 1998 an ice storm extending from the St. Lawrence Valley across northern New England left 1.5 million people in the United States without power for up to three weeks. Two ice storms hit Texas, Arkansas, and Oklahoma in December 2000, both causing prolonged outages and extensive damage to the power distribution system.

Structural engineers and utilities need better information on ice storm frequency, extent, and extreme loads to design ice-sensitive structures that are capable of withstanding ice storm loads and which are economically viable.

SOLUTION

The atmospheric icing group at CRREL is working to fill this need.

Ice accretion simulations

Because ice loads are not regularly measured, we are using ice accretion models we developed with historical data at weather stations to hindcast accreted ice loads on structures in past freezing rain storms. We use these modeled ice loads in an extreme value analysis to map extreme ice loads and concurrent wind speeds for national standards. We also determine site-specific extreme ice loads for existing or planned transmission line routes and communication towers (http://www.crrel.usace.army.mil/partnering/wind_roses.html).

Field measurements

To validate our models and develop a database of structural ice loads, our ice storm team surveys storms as they occur, mapping their extent and severity (http://www.crrel.usace.army.mil/news/news.htm)

Instrumentation

Although rime icing occurrences are less widespread than freezing rain storms, they often instigate failures of transmission lines and tall communication towers. Our field work at the summit of Mount Washington, where riming occurs on a weekly basis, has provided valuable data on in-cloud icing. We used rime measurements from many years to develop a formula to determine the density of rime ice, and have developed a method for calibrating Rosemount ice detectors to use at remote sites to determine the liquid water content of supercooled clouds.

Failure database

We also have developed a database of communication tower failures for the United States and Canada to help quantify the regional frequency of tower failures from ice and wind loads.

Ice-phobic coating evaluation

Commercially available ice-phobic coatings have been applied to structures to reduce the accretion of atmospheric ice. However, there is no standard method for quantifying the short- and long-term effectiveness of various products. CRREL has developed a facility for measuring the bond strength of ice and has found that attention to sample preparation in conjunction with careful control of test conditions leads to reproducible results. (http://www.crrel.usace.army.mil/techpub/factsheets/pdfs/043.pdf)

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PRODUCTS

We produced a map of extreme ice loads from freezing rain for the United States for the ASCE7-98 Standard and are updating that map for the 2001 revision (ftp://ftp.crrel.usace.army.mil/pub/kjones). While a similar map for in-cloud icing is in the future, our calibration of instruments at Mount Washington will give us the tools necessary to determine rime icing severity at particular locations—for example, for wind farms or tall towers.

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